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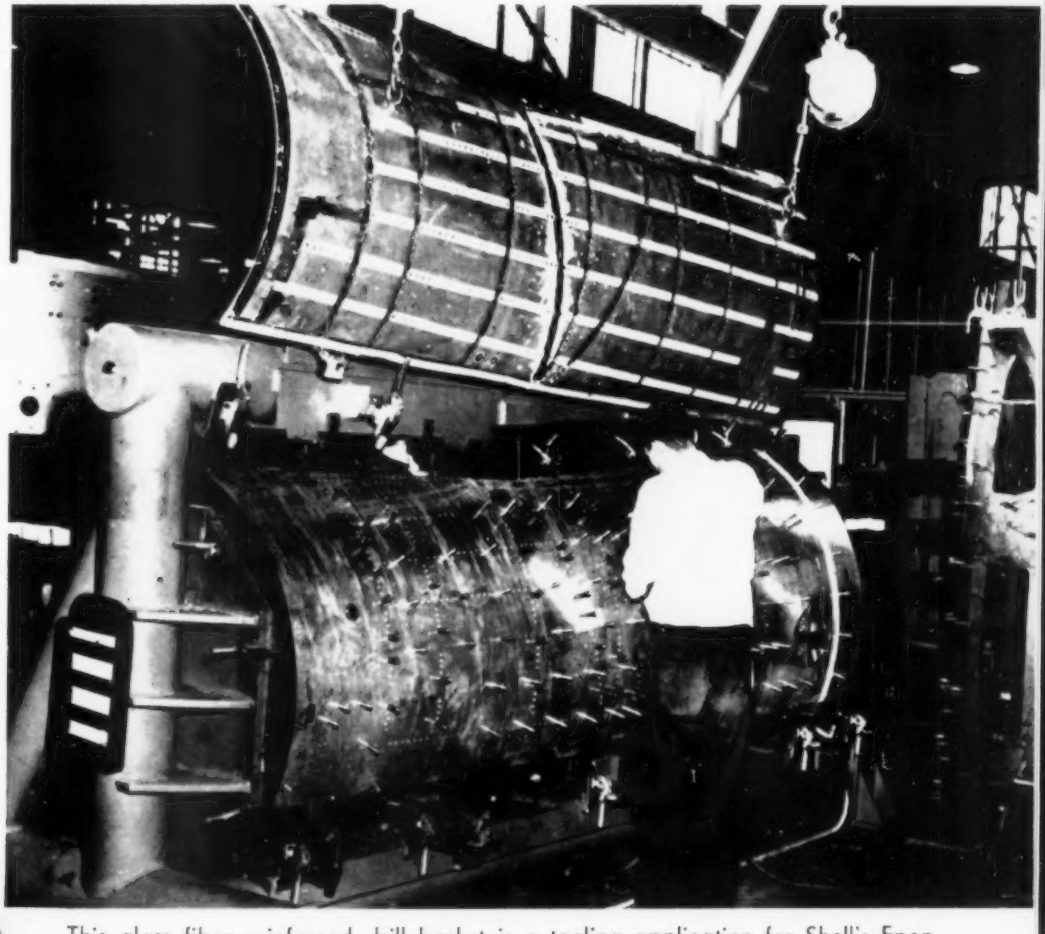
VOLUME 10, NUMBER 8 • OCTOBER, 1954



This glass fiber reinforced drill basket is a tooling application for Shell's Epon resin, used in the production of jet fighter planes.

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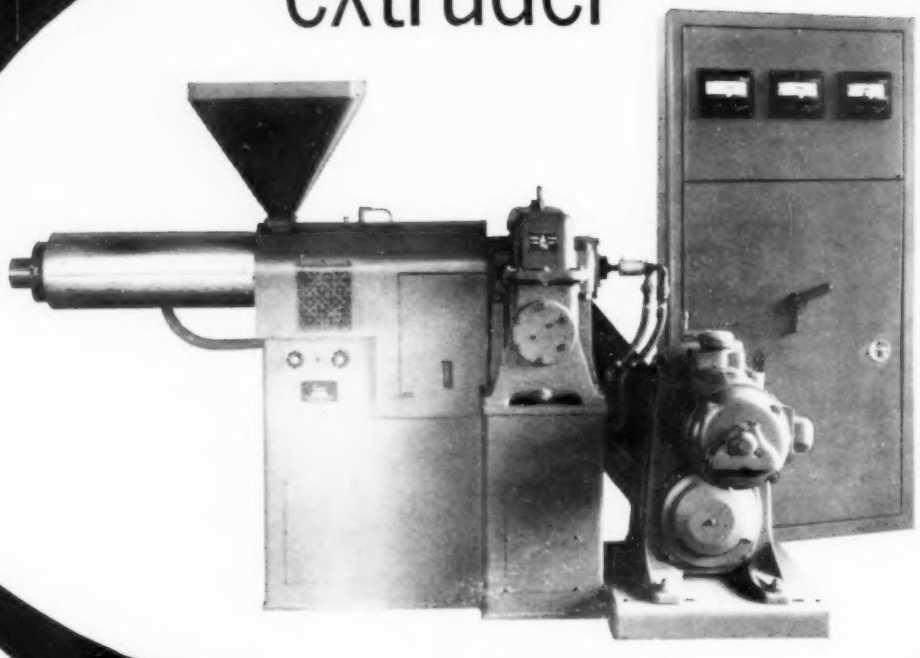
Egan

extruder



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SPE JOURNAL

VOL. 10 October, 1954 No. 8

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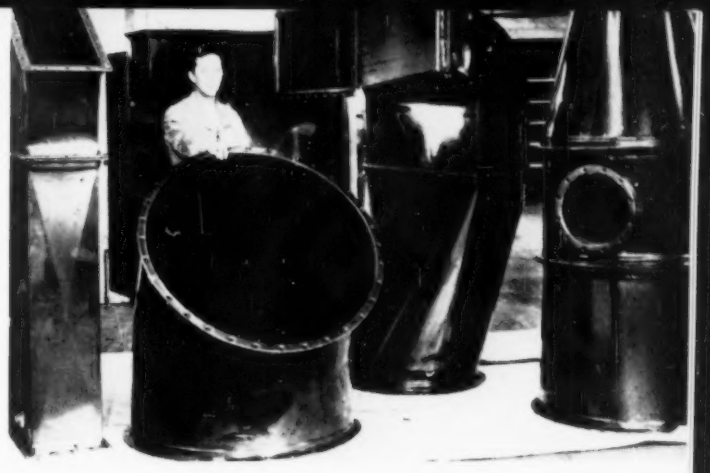

Large chemical processing equipment exposed to corrosive fumes is given a tough, baked-on coat of Bakelite vinyl resin-base plastisols to extend service life and cut maintenance costs.

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Book Reviews . . . .

PLASTICS ENGINEERING HANDBOOK, second edition (S.P.I.), published by Reinhold Publishing Co., 130 Park Ave., New York. 791 pages plus index. $15.

This is the second edition of the "S.P.I. Handbook" which first appeared in 1947, and is about twice as large as the first edition. It has been brought up to date and new chapters added. Though the book is the result of the work of a great many people, careful editing gives a welcome uniformity of readability.

Chapter headings are: Classification of Rigid Materials; Molding; Preforming, Drying and Preheating; Extrusion and Extrusion Machines; Forming, Drawing and Postforming; Reinforced Plastics; Casting; Tooling With Plastics; Embedding; Vinyl Dispersions; Laminated Products; Design of Molded Articles; Standards for Tolerances on Molded Articles; Design Standards for Inserts; Mold Design and Recommended Steels; Machining, Finishing and Decorating; Cementing, Welding and Assembly; Assembly Gluing; Testing Plastics Articles; and Voluntary Commercial Standards of the Trade.

Each chapter is practical and detailed, with many drawings and photographs. The book is designed for those who mold and use plastic articles and is basic and authoritative.

Your reviewer has only one suggestion for improvement. Since any given reader will be mainly interested in those chapters dealing with his speciality, it might be useful to include at the end of each chapter some references for further reading in that subject.

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FASTEST PRESS OPERATORS— **WANT IT!**

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Across the Editor's Desk . . . .

• The people who use or should plastics in their products need to be informed, in detail and by experts, just what plastics can and cannot do, and how to use them. Such exchange of information not only helps manufacturers to make best selections of materials, but gives the plastics industry the best possible chance for expansion.

Such a program is the Plastics Symposium being held jointly by the American Society of Mechanical Engineers and the Newark and New York sections of SPE, under the general chairmanship of J. H. DuBois.

The program is:

Sept. 20—"The Plastics Industry," Hiram McCann
"The Organic Plastics," H. M. Richardson

Sept. 27—"The Ceramic Products," A. J. Monack
"Cold Mold Plastics," Leon R. Egg

Oct. 4—"Natural and Synthetic Rubber Products," D. E. Jones
"Silicone Rubber," Alex E. Javitz
"Elastomers and Non-Rigid Plastics," J. K. Honish

Oct. 11—"Cast Plastics," M. Wismer
"Fabricated Parts," J. E. Niemeth

Oct. 18—"Thermosetting Plastics," S. E. Tinkham
"Thermoplastic Products," John LaBelle

Nov. 1—"Reinforced Plastics," J. Kinsey
"Extrusion Plastics and Blownware," George Pickering

Nov. 8—"Appearance Design to Prototype," Edward Ferrari
"Material Selection Considerations," J. H. DuBois

Nov. 15—"Review Forum and Exhibit."

Meetings will be at 7 p.m. in the Engineering Societies Bldg., 29 West 39th, Room 501, New York City.

• Don't overlook the printed specifications for laminated plastics of the various government agencies, which is being distributed by the Synthane Corp., Oaks, Pa. More about this in the "Industrial Literature" section.

California SPE Meets with A.S.T.E.

The Society of Plastics Engineers, Inc., Southern California section, will sponsor an industrial conference coincident with the first American Society of Tool Engineers' Western Industrial Exposition and that society's national convention in Shrine Auditorium and Exposition hall here next March.

Announcement of the special conference is made by Austin H. Herbst, Technical Director of Irvington Varnish and Insulator Division, Minnesota Mining and Manufacturing Company and president of the Southern California section of S.P.E. Through the cooperation of the ASTE, the "plastics" conference will be held in the Auditorium of the ASTE exposition.

"We believe the ASTE Western Industrial Exposition is a natural for meetings devoted to the current problems confronted by the plastics engineers. The scope of the show, which will be the largest of its kind ever held on the West Coast, will enable us to study equipment and processes of value in our particular field as well as related processes and equipment," Herbst said.

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Industrial Literature . . .

Table of Military Specifications

A complete tabulation of the latest military and government specifications for 24 grades of thermosetting laminated plastics; a completely revised and up-to-date version of several bulletins that have been very helpful to manufacturers of government purchased equipment, designers, engineers, purchasing and production men is offered by Synthane Corporation, Oaks, Pa.

This chart may be had by writing the Synthane Corp., Oaks, Pa.

Lead Screw Tapping Tools

Bulletins recently issued by Automatic Methods, Inc. describe the complete line of **Lead Screw** Tapping Tools.

The new "Auto-Tap" **Lead Screw** Tapping Heads incorporating a lead screw, reversing mechanism, and positive depth control in a single compact unit which clamps to the quill of any drill press, are shown in Bulletin #601. Both the #600 Series (tap capacity #0 to 5/16") and the #700 Series (tap capacity #10 to 3/4") can be quickly set up for manual, semi-automatic, or automatic operations.

Lead Screw Tapping Attachments for converting drill press tapping set-ups to **lead screw** tapping are described in Bulletins #201 and #103.

The advantages of the lead screw method of tapping, simple fixtures, and typical applications are described in detail. Complete specifications on all models are also included in the bulletins.

The manufacturer—Automatic Methods, Inc., 965 W. Grand St., Div. 192, Elizabeth, N. J., will gladly furnish free literature on request.

Protective Coating Glossary

A glossary for the protective coating industry has been printed in book form, at a price of one dollar, by R-B-H Dispersions, Interchemical Corp., Bound Brook, N. J.

Booklet On Plasticizers

A booklet on Paraplex and Monoplex plasticizers is available from Rohm and Haas Co., Washington Square, Philadelphia 5, Penna.

Balsa Wood and Plastics

Balsa wood and plastics go together. Want to know how? Write International Balsa Corp., 96-100 Boyd Ave., Jersey City, N. J.

H-P-M Offers Bulletin On Its New Line

The Hydraulic Press Mfg. Company, Mount Gilead, Ohio, is offering a 12-page bulletin, No. 5406, on its new line of plastics injection molding machines for molding polystyrene, acrylics, cellulose acetate, cellulose acetate-butyrate, elastomeric vinyls, nylon and other widely used thermoplastics. Two of the new machines described in this bulletin were demonstrated at the recent National Plastics Exposition held in Cleveland, Ohio.

H-P-M's new bulletin No. 5406 is very complete with full specifications on all machines up to and including the world's largest injection machine, which has a 400 oz. capacity and 3000 ton mold clamping force.

H-P-M's line of injection machines are widely used in housewares and appliances—particularly in the refrigeration, radio and television fields—toys packaging, automotive and communication equipment.

H-P-M machines range in price from $15,000 to $200,000 each, depending upon size. Bulletin No. 5406 is available by writing to The Hydraulic Press Mfg. Company, Mount Gilead, Ohio, U. S. A.

Up to 25% Faster Production for big moldings like these with SMD-3500

36-ounce crisper pan molded by **General Electric Co.**, Decatur, Ill.

Cake cover molded by **Columbus Plastic Products Co.**, Columbus, Ohio.

These big, glossy-surfaced, crystal-clear moldings show what can be done with a new general-purpose styrene molding material—BAKELITE SMD-3500.

The high plasticity of SMD-3500 permits it to fill more cavities within the same cycle needed for ordinary polystyrenes. Production time for the refrigerator crisper tray was cut 25 per cent with SMD-3500. Although cycles are fast, pieces are remarkably free from stress crazing and weld lines, as the cake cover shows. SMD-3500 can be used on all types of injection molding machines.

Another new BAKELITE Styrene molding material — SMD-3000 — is notable for its resistance to high heat distortion. Like SMD-3500, it is produced on specially-designed, automatic equipment to ensure uniformity of color and molding properties. An advanced system of quality control is constantly in effect. The same Bakelite Company technical resources that developed these new materials are at your service in applying them to your products. For detailed information, write Dept. YR-43.

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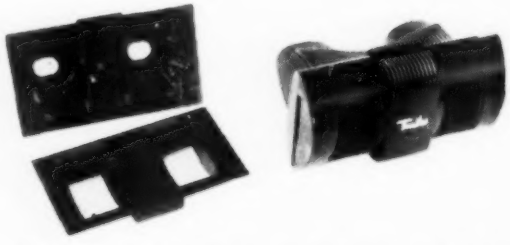

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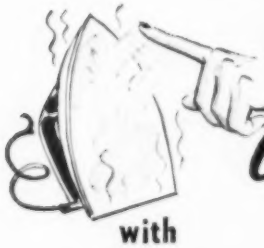

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News of the Industry . . .

Stokes Forms Electromold Co.

Stokes-Trenton, Inc. announces the formation of an associated company ELECTROMOLD CORP., which has been established for the purpose of making cavities and and other mold parts for plastic molds by the process of Electro-forming. The process used is a recent English development and patented throughout the world. The cavities and other parts are formed of a hard (45-50 R.C.) nickel cobalt alloy. They are stress free and tough.

This new electroforming technique is an important advance in the making of molds. Great economies are possible in many types of molds which are expensive to produce by conventional means. Since the cavities are formed hard and are not subjected to heat treatment, greater accuracy can be achieved in irregular shapes such as cavities for plastic gears. Many molds which are impractical to make by machining, or are too costly, now become practical. Electroformed molds will bring a whole new world of textured surfaces to the field of molded plastic. The new process will greatly extend the use of plastics in the field of novelty buttons and jewelry parts.

ELECTROMOLD CORP. will supply cavities and other mold parts ready for installation in a mold base. It will supply such parts to all divisions of the plastic mold trade, such as custom or proprietary molders and mold makers, throughout the nation. ELECTROMOLD CORP. offers the same service for electroformed mold parts as other tool makers provide in the field of hobbing and casting.

The address of ELECTROMOLD CORP. is 140 Enterprise Avenue, Trenton 9, New Jersey.

Mycalex Price Reductions

Mycalex Electronics Corporation, Clifton, N. J., announces "substantial" price reductions, effective September 15, on its complete line of Mycalex 410 telemetering commutator plates and Mycalex Model TM 51 Series telemetering switches.

Mr. DuBois said Mycalex 410 commutator plates are essential components in most of the guided missiles now being manufactured or under development. He quoted the chief engineer of one leading manufacturer of guided missiles as saying, "We have worn out every component of our telemetering switches except the Mycalex 410 commutator plate."

Society of Rheology to Meet

The Society of Rheology will hold its 1954 Annual Meeting in Washington, D. C., on November 3-5, 1954. The technical sessions will be held at the National Bureau of Standards, and the headquarters hotel will be the Sheraton Park.

The following four main groups of papers are scheduled: (1) time dependent mechanical behavior of monomeric liquids, elastomers, plastics, glass, and asphalts (2) statistical and molecular theories of liquids with particular regard to rheological processes, (3) volumetric strain in monomeric liquids, glass, and organic polymers and (4) critical velocities and impact strength, anistropy and chemically induced relaxation of fibers. In addition, individual papers will be given on a wide variety of rheological topics.

Further information about the meeting can be obtained by inquiry addressed to Mr. F. D. Dexter, Publicity Chairman, Bakelite Company, Bound Brook, New Jersey.

DESIGN and PRODUCTION NEWS

FOR DESIGN AND MATERIALS ENGINEERS

Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company OCT.-NOV. 1954

Smaller, Lighter Rupture Discs... Lined With KEL-F® Plastic... Now Used In Highly Corrosive Systems

Using coatings and seals of KEL-F plastic to overcome corrosion, lightweight, small rupture discs of aluminum now provide protection for low pressure and vacuum vessels. Discs with bursting pressures ranging from 5 to 100 psig are now possible. Premature bursting due to corrosion has been eliminated. Discs are smaller and afford a greater degree of pressure control than previous types.

A lining of KEL-F plastic on the standard (right) and a film seal in the new "lug" type rupture disc (left) permit them to be used safely with practically all corrosive materials, at temperatures up to 250°F.

Black, Sivalls & Bryson, Inc., Kansas City, Mo. manufacturers of control equipment, pioneered this use of KEL-F plastic film.

For further information ask for Application Report C-119

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS. write

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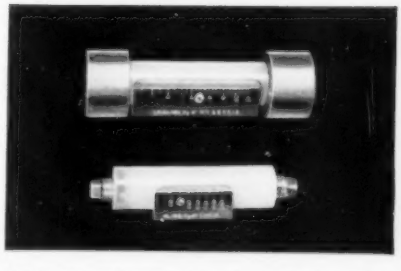
Clarity, dimensional stability, accuracy and damage resistance make these flowmeters made from KEL-F polymer outstanding. In contact with extremely corrosive hydrogen fluoride for two years on low-pressure purge lines, they show no signs of "giving up".

Chemically-inert, the plastic tubes are unattacked by the HF even at 300 F. Machined to precision dimensions, they maintain original metering accuracy. Flow tubes have remained clear to permit easy float visualization.

The Brooks Rotameter Company, Lansdale, Pa., produces these corrosion-resistant flowmeters. Flow tubes are machined of rod extruded from KEL-F polymer Grade 300 by the United States Gasket Company, Camden, New Jersey.



For further information ask for Application Report C-120

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Industry Notes . . .

Heli-Coil Thread Repair Kit

This handy kit, available from Heli-Coil Corporation, Danbury, Connecticut, speeds thread repair operations in all materials and may be used in original design and assembly of jigs, dies, templates, fixtures and tools. The kit contains a total of 125 inserts in four sizes, with all necessary installation tools.

Agile Thermoplastic Welding Kit

The Agile Welding Kit is the latest addition to the complete line of Agile products for thermoplastic welding and contains basic tools necessary for proper fabrications as well as a vast source of information on welding of plastics.

Wherever fabrication of polyethylene and nonplasticized polyvinyl chloride, accepted plastics material of construction, is carried out, the Agile Welding Kit is invaluable. Both large and small scale fabrications will benefit by use of this kit.

For further information write to The American Agile Corporation, P. O. Box 168, Bedford, Ohio.

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Incorporation of all the functions of conventional presses directly into the electrode, makes the new Eutomag Magnetic-Bar Electrode particularly useful for the welding of large areas of plastic sheeting. Electrodes of this new type have particular advantages for automatic machinery, since they facilitate simple, high-speed mechanical feeds. Plastic sheeting can be wrapped around the keeper bar for the production of unlimited lengths of plastic tubing for packaging and other requirements.

Write to Electronic Processes Corporation, 921 San Antonio Road, Los Altos, California.

Half A Million Women

"400,000 Women must be right," and who is to disagree? The story of the Kopper's consumer-tested colors for polystyrene wall tile is a bound booklet with color samples and sales-aids, published by the Koppers Company, Inc., Chemical Division, Pittsburgh 19, Pennsylvania. Write for your copy.

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When RCA electronic engineers designed their first TV color tube for mass production, they discovered the need for a material with special properties to be used for the tube base molding. Arc resistance and superior dielectric strength, as well as resistance to heat and humidity, are essential qualities in this critical component. In their search for the best suited material, RCA investigated mineral filled PLASKON Alkyd and discovered that this material offers all of these features . . . and in addition, it affords an extremely high rate of production due to its ready moldability. The choice was an obvious one . . . PLASKON Alkyd because of its favorable electrical characteristics and possible production economies.

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Barrett PLASKON®

For further information on PLASKON Plastics and Resins, address BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, N. Y. Hanover 2-7300

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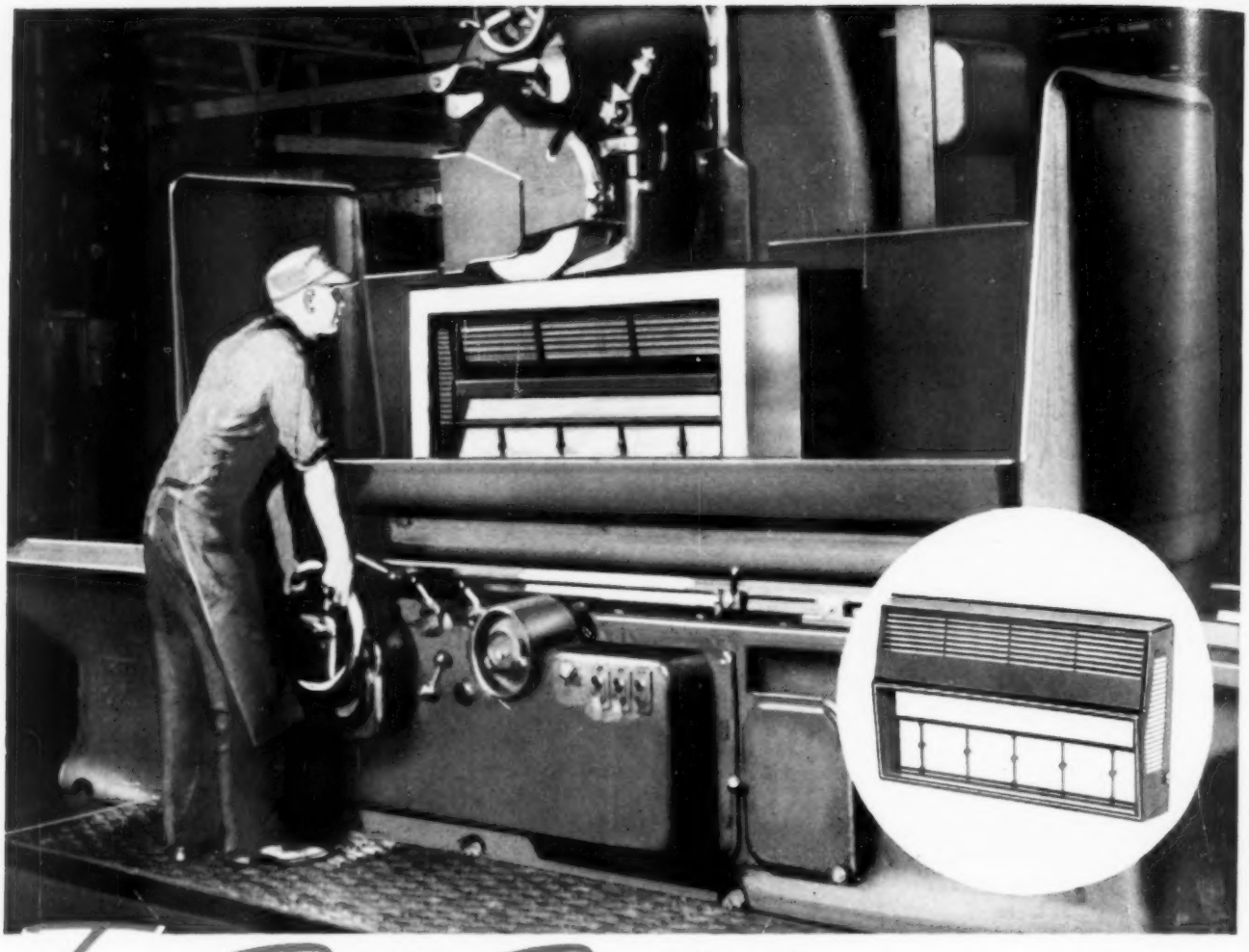

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AT LOWER COST... A PERFECT MOLD

At Newark Die Company skilled craftsmen guide modern machines to fashion molds of superior quality . . . a vital step in making a better molded product at lower cost. Here a giant Mattison surface grinder readies a mold for the ornamental grille of an air conditioner. With unerring precision it squares the mold and smooths the parting surface to a flawless finish . . . one of the many steps in the making of a perfect mold. Into this and every stage of mold-making at the Newark Die Company goes a combination of engineering know-how, proud craftsmanship and unsurpassed facilities . . . a combination that has set mold-making standards for more than thirty years.

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YOUR NATIONAL OFFICE

A Restatement of SPE Independence

Occasionally confusion develops in the public's mind over the possible affiliation of the Society of Plastics Engineers with other groups. Since we are very proud of it, perhaps it is timely to state once again that from our very beginning over twelve years ago, the Society has been a completely independent organization. In some of our activities it has been practical to co-operate with other groups in accomplishing a common objective. In all of our endeavors however we maintain our financial and organizational independence.

The SPE JOURNAL is an example. Through over ten years of work and development by SPE members the JOURNAL has been custom-designed to provide current technical information to men in the plastics industry. It is the official organ of the Society—owned, edited, printed, and published by the Society. And no other magazine is financially or organizationally affiliated with the Society or with the SPE JOURNAL in any way.

Degree Course in Plastics Engineering Begins

September saw the birth of what is believed to be the first full four year degree course in plastics engineering in this country. Lowell Technological Institute in Lowell, Massachusetts developed this pioneering project with the help and counsel of a Plastics Industry Advisory Committee, on which several SPE members served.

Dr. Russell W. Ehlers has been appointed to head the new Department of Plastics Engineering. Present plans call for the development at Lowell of one of the most modern plastics laboratories in the country.

ASME Plastics Symposium

The American Society of Mechanical Engineers, in co-operation with the Society of Plastics Engineers, will conduct a plastics engineering symposium for the Metropolitan Section of ASME in New York City September 20 through November 15. Speakers will cover the philosophy, materials, methods, limitations, equipment and services of the plastics industry, with a view toward aiding the mechanical engineer in designing products making effective use of plastics materials. Among the speakers is Mr. John LaBelle, National President of SPE and Director of Sales of the Foster Grant Company, who will speak at the October 18 session.

Mr. J. H. DuBois, former National President of SPE and Vice President—Engineering of Mycalex Corporation of America is the General Chairman of the symposium. It is planned to have Mr. Harold Schwartz, President, New York Section of SPE and Chief, Plastics Division of Empire Brushes, Inc., and Mr. Joseph Bonanno, President, Newark Section of SPE and Treasurer of The Lionel Corporation, as session moderators.

The symposium will end on November 15 with a joint meeting of the Newark and New York Sections of SPE and the Metropolitan Section of ASME. And the two SPE Sections will provide an exhibit of plastics products for this meeting.

Sincerely,

P. L. Underwood

Executive Secretary

The Society suffered a serious loss in the recent passing of Frank Bailey, former National Director of the Milwaukee Section.

Industry Notes . . .

Logo Announces Stipple and Spatter

Two new color and finishing effects, STIPPLE and SPATTER, are announced by LOGO, INC. The non-finger-printing and defect coverage of STIPPLE and the unusual and striking color effects of SPATTER suggest broad usage in the plastic field.

LOGO STIPPLE X-88 is a stipple coating which forms a discontinuous film producing a textured base for use on most plastics and a variety of other surfaces prior to applying a regular LOGOQUANT finish.

LOGO SPATTER R-69 produces a spatter effect and is applicable to either the first surface of opaque or the second surface of transparent plastic.

Further information on both LOGO STIPPLE X-88 and LOGO SPATTER R-69 can be obtained from LOGO, INC., 13799 South Avenue "O", Chicago 33, Illinois.

Plastylite Has New Plant

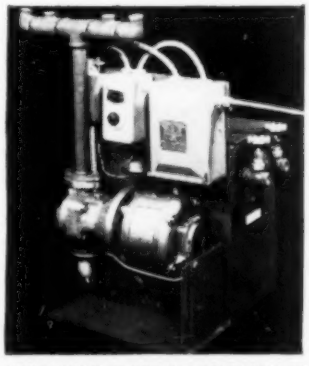
We take great pleasure in announcing that Plastylite is now constructing a new and larger plant where we will continue as custom molders of Phenolic, Urea and Melamine products; as well as the custom molding of Longplaying and 78 RPM Vinylite and Plastic phonograph records.

Our new site will be located on North Drive, in North Plainfield, New Jersey.

H. M. Weinraub, President, will be in charge of plant operations. Robert J. Goldstein will continue in charge of Sales and Personnel.

GET THE IMS ECONOMY CIRCULATOR from
INJECTION MOLDERS SUPPLY CO.
3514 Lee Road Cleveland 20, Ohio

Now
EXACT INJECTION MOLD TEMPERATURE CONTROL
at a really reasonable cost



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COMPARE RESULTS

IMS MOLD HEAT CIRCULATOR
Price Complete . . . $349.50

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Performs The Same Job
As Big Costly Units
At Less Than Half The Price!

NEWLY DESIGNED TRAP

virtually eliminates maintenance!

Most striking feature of this trap is its simple design. Only one moving part — a solid stainless steel disc — virtually eliminates maintenance.

The trap is small, easily installed, immune to water hammer, vibration and corrosive elements. Uses same valve seat and head for all pressures to 600 psi and temperatures to 950°F.

Check these advantages to your own satisfaction. Write today for a 60-day trial giving size, capacity and pressure conditions.

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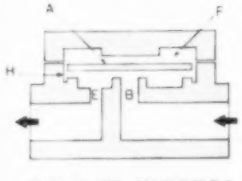
Thermodynamic
TRAP



HOW IT WORKS!

Air and/or condensate raise valve seat disc A, discharge thru E. When steam follows, greater velocity causes it to strike body at H thus building up pressure in chamber F. This causes disc to seat, closing tube B. As pressure in F decreases by condensation, pressure in tube B raises disc and cycle is repeated.

2099-F

SECTION MEMBERSHIP COMPETITION

	MEMBERSHIP		NEW APPLICANTS			
	Oct. 1, 1953	Oct.-Jan.	Jan.-April	April-Aug.	August	[illegible]
Baltimore-Washington	39	1	4	1	1	
Buffalo	65	5	3	2	6	
Central Ohio	33	1	2	4		
Chicago	315	21	13	7	5	
Cleveland-Akron	148	17	16		7	
Connecticut	86	7	8	7	1	
Detroit	173	13	16	9	3	
Eastern New England	132	5	13	6	3	
Golden Gate	32	5	5			
Miami Valley	102	2	5	1	1	
Milwaukee	1		22	3	1	
Newark	321	31	17	14	3	
New York	248	22	50	28	31	
Northern Indiana	21	1	4			
Northwest Pennsylvania	75	8	3	2		
Ontario	43	23	31	12	1	
Philadelphia	174	9	23	12	1	
Pittsburgh	6	8	5	3		
Quebec	25	16	11			
Rhode Island & SE Mass.	68	1	3	6	1	
Rochester	65	10	8	3	1	
St. Louis	71	13	6	2		
Southeastern Ohio	36	4	3	2		
Southern California	96	15	13	5		
Southern Section	3		43	11	9	
South Texas	32	6	7	7		
Toledo	59	0	1	2		
Upper Midwest	54	5	5			
Western New England	155	15	20	6		
Non-Section	33	0	8	1		
TOTALS	2704	267	368	166		

GRAND TOTAL—3596

Set Sail for Atlantic City

Eleventh SPE Technical Conference Plans

Atlantic City, New Jersey, January 19 Through 21, 1955

"Growth Through Engineering"

More news of the Program of the Technical Conference January 19-21, 1955.

The most important part of any Technical Conference is, of course, the subjects discussed and the speakers who discuss them. The Speakers Committee, under the able chairmanship of Jerome Formo has, even at this early date, (Sept. 1 press deadline for this issue) an amazing number of commitments from the eminent individuals who have been asked to cover the subjects selected as being most timely and of the widest general interest.

All told, 36 speakers have been lined up, who will sit on eight separate panel discussions and cover thirty-eight different subjects. The work of the speakers committee has been so assiduous that at many times during the conference, three sessions will be under way simultaneously. Individual members with diversified interests would do well to bring an associate or two along to make sure of adequate coverage, although the program committee is making every effort not to schedule two papers of special interest to any specific group or branch of industry at the same time in separate sessions.

A panel discussion will be held on **Reinforced Plastics**, in response to demand on the part of the members for a polyester-fibreglass discussion. This panel will be moderated by I. M. Scott of Winner Manufacturing Co.

In a related field will be a paper presented by William E. Braham of Zenith Plastics on **Manufacturing and Design Techniques in Asbestos Reinforced Plastics.**

Another subject of popular appeal is the one on **Vacuum Forming of Sheet Plastics.** E. Bowman-Stratton of the Auto-Vac Co. will preside.

Injection Molders will be interested in a symposium on **New Techniques in Controls** with notable contributions by Everett R. Brown of Automatic Temperature Control Co., Gordon Thayer of Dow Chemical Co., and H. E. Shugars, Wheelco Instruments.

Also of interest to this group as well as to others is the paper on **Electroformed Hard Nickel Mold Parts** by W. J. B. Stokes, II, of Electromold Corp. This process is understood to permit making more accurate molds than has been possible heretofore, as well as executing highly detailed or curved parting-line cavities at a lower cost than by conventional methods.

Those awaiting news of new plastics will welcome hearing from Anthony F. Forni of General Electric Co. on **Silicone Rubbers;** G. G. Freygang of Rohm & Haas on **Isocyanate Resins,** and E. W. Cronin of Hercules Powder Co. on a new material of the fluorocarbon type, **R.D. 115.**

Compounding and Processing of Styrene Copolymer Resins will be covered by R. J. McCutcheon of Goodyear Tire & Rubber Co., while another speaker will talk on compounding of vinyls.

As other speakers agree to their assignments, they will be listed in future issues. Several important papers will cover new techniques in testing various materials, and others will deal with fabricating, finishing, and printing.

Experts in product design, application of plastics to appliances, and tool design are being booked to discuss their specialties, and it is expected that the remaining panels will be filled by the time of the next issue.

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All New HPM

ACCESSIBLE POWER UNIT • HIGH SPEED INJECTION • BIG PLATENS

A complete line of stock presses from 50 to 200 tons, designed specifically for molding reinforced plastics. Larger sizes built to order.

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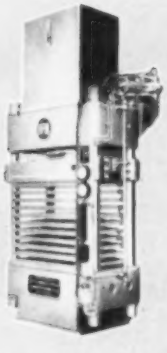

Multiple hot plate presses with steam or electrically heated plates for compressing or curing laminated materials. Built to customer's requirements.

THE WORLD'S *MOST COMPLETE LINE* OF PLASTICS INJECTION MACHINES

From 6 ounces to 400 ounces with mold clamping forces from 150 to 3000 tons . . . that's H-P-M's new line! Here is by far the largest and most comprehensive group of injection molding machines ever offered to the plastics industry. Automatic machines . . . pre-plasticizing machines . . . conventional semi-automatic machines . . . every one a proven design with faster speeds . . . greater production output. Truly, H-P-M offers you the most modern production machinery available anywhere!

Each machine is NEW . . . designed with so many outstanding improvements that even the most experienced injection molder will be amazed. Talk to an H-P-M plastics engineer today!

SPECIFICATIONS

STANDARD INJECTION MACHINES					
MODEL NUMBER	150-H-6	300-H-12	400-H-20	800-H-48	1200-H-80
Capacity (Oz.—Single Feed)	6	12	20	48	80
Capacity (Oz.—Double Feed)	8	16	28	64	100
Material Injected (cu. in. per min.)	440	1035	1330	2895	2850
Plasticizing Capacity (lbs. per hr.)	60	100	135	300	400
Mold Clamp Capacity (tons)	150	300	400	800	1200
Mold Space (hor. x vert.):					
(a) Full Platen Vertically	10½"x25"	16½"x33"	20½"x 42"	36"x54"	40"x68"
(b) Full Platen Horizontally	20½"x15"	30"x20"	36"x26½"	54"x36"	60"x48"
Daylight Opening without Ram Spacer	20"	30"	40"	55"	60"
Daylight Opening with Ram Spacer	16"	26"	34"	47"	48"
Mold Thickness without Ram Spacer	10"	10"	15"	20"	24"
Mold Thickness with Ram Spacer	6"	6"	9"	12"	12"
Clamp Travel (max.)	10"	20"	25"	35"	36"
Motor Horsepower	20	40	50	100	100
Shipping Weight (pounds)	14,500	22,000	39,000	75,000	125,000

NOTE: All ratings based on molding general purpose polystyrene.

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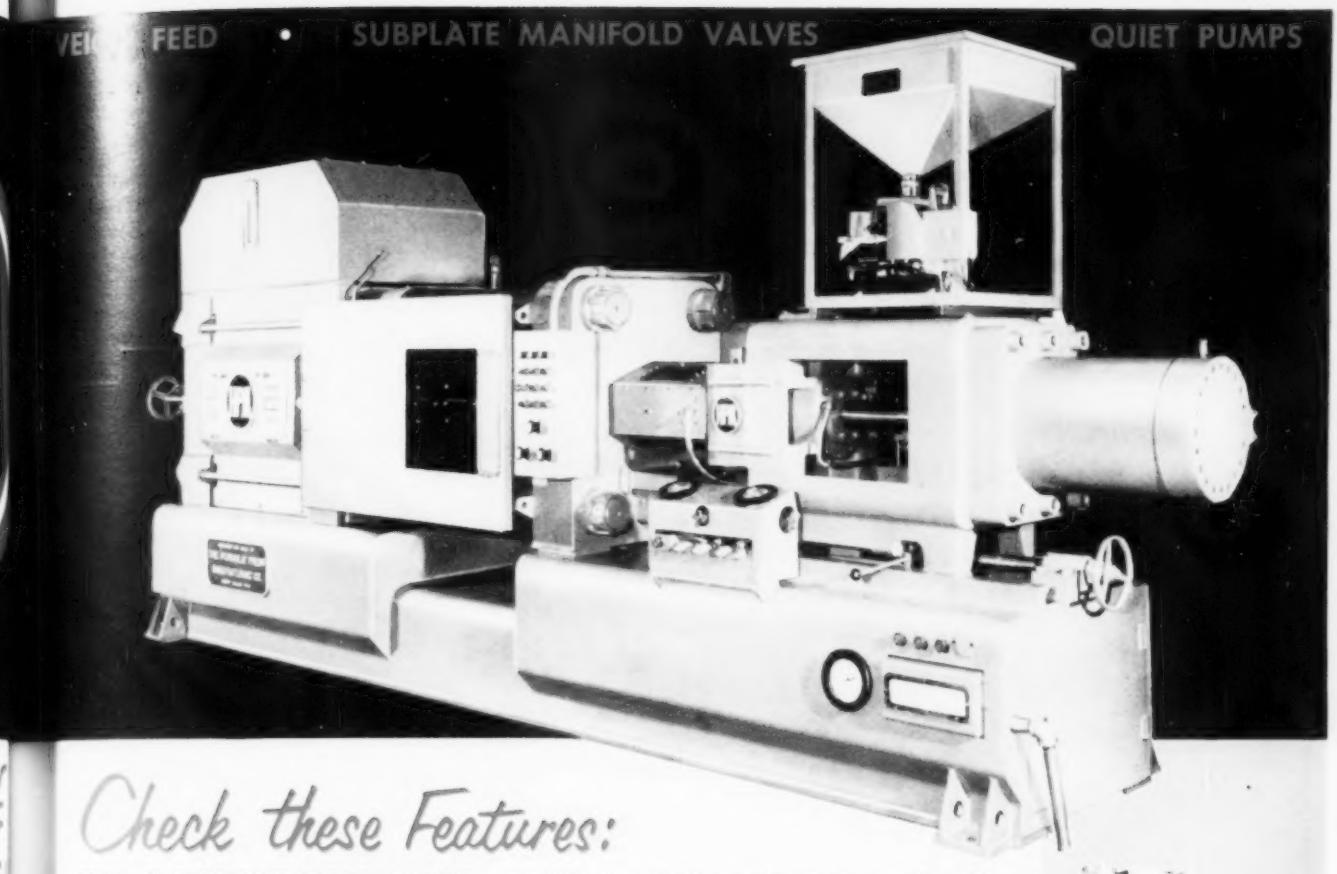
THERE'S AN H-P-M TO MOLD IT-



Check these Features:

FULL HYDRAULIC MOLD CLAMP — provides fast closing and opening speeds with automatic adjustable slow downs. No adjustments required for different mold thicknesses, which mean big savings in mold set-up time.

EXTRA-LARGE PLATENS — will accommodate big molds . . . located at ideal operator height, requiring no platforms or pits.

ACCURATE, COMPENSATING WEIGH FEEDER — is standard equipment on all conventional, large capacity models.

PLENTY DAYLIGHT & STROKE — permit production of deep parts. Quick changing ram spacer permits use of thin molds without bolsters.

OVERHEAD OIL TANK — keeps oil clean and provides gravity prefill for fast clamp pressure build-up.

HIGH-SPEED INJECTION UNIT — combines new high-output, 3-zone plasticizing chamber with injection plunger speeds over 50% faster than on previous models. Entire injection unit can be retracted hydraulically.

NEW H-P-M HYDRAULIC CIRCUIT — employs exceptionally quiet pumps and a new leakproof manifold sub-plate valve system which reduces hydraulic piping to a minimum.

PRE-PLASTICIZING INJECTION MACHINES					
MODEL NUMBER	400-P-48A	1200-P-200	1200-P-200A	3000-P-200A	3000-P-400A
Capacity (Oz.–Single Feed)	48	200	200	200	400
Capacity (Oz.–Double Feed)					
Material Injected (cu. in. per min.)	1340	6950	3000	6950	7200
Plasticizing Capacity (lbs. per hr.)	180	400	400	600	600
Mold Clamp Capacity (tons)	400	1200	1200	3000	3000
Mold Space (hor. x vert.):					
(a) Full Platen Vertically	21½"x 40"	40"x68½"	40"x68½"	49"x88"	49"x88"
(b) Full Platen Horizontally	36"x25½"	60½"x 48"	60½"x 48"	49"x88"	49"x88"
Daylight Opening without Ram Spacer	54"	60"	60"	60"	108"
Daylight Opening with Ram Spacer	46"	48"	48"	48"	84"
Mold Thickness without Ram Spacer	24"	24"	24"	30"	48"
Mold Thickness with Ram Spacer	16"	12"	12"	18"	24"
Clamp Travel (max.)	30"	36"	36"	30"	60"
Motor Horsepower	50	355	175	355	355
Shipping Weight (pounds)	46,000	154,000	143,000	264,300	324,300

NOTE: All ratings based on molding general purpose polystyrene.

● Stock sizes 100, 200, 300 and 500 tons. Larger sizes up to 2500 tons built on special order.

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● Stock sizes 100, 200, 300 and 500 tons. Larger sizes up to 2500 tons built on special order.

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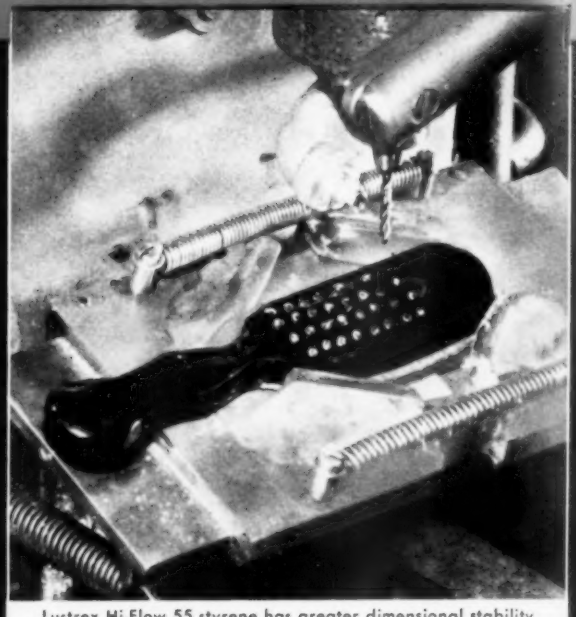
Better . . . Faster . . . and at Lower Cost!

"LUSTREX HI-FLOW 55 styrene cut our cycle time from 120 to 78 seconds!"

Mr. Joseph Josephs, President
Bennington Brush Company
Bennington, Vt.

Brush backs, molded of Lustrex Hi-Flow 55 styrene, are removed from Bennington Brush Company's injection machine in record time!



Lustrex Hi-Flow 55 styrene has greater dimensional stability — will not crack when drilled!

Speed cycles—cut costs—boost profits with HI-FLOW 55 MONSANTO LUSTREX Styrene Plastic

"Monsanto's Lustrex Hi-Flow 55 styrene is superior to everything else on the market," says Mr. Josephs. "We are producing crystal-clear, quality products cheaper and faster because Lustrex Hi-Flow 55 styrene lets us reduce molding temperatures

from 450° to 400° in rear of heating chamber,
from 425° to 380° in the center,
from 400° to 360° at the nozzle.

"Lustrex Hi-Flow 55 styrene's new low molding temperature requirements eliminate shrinkage, flaws and weld marks, reduce stresses and strains... cut our injection cycle 40%! Rejects have been cut to a minimum. And the production capacity of our machines has been increased—**even in excess of its maximum rating**—with Lustrex Hi-Flow 55 styrene!"

Results like these are typical of what happens when molders switch to Lustrex Hi-Flow 55 styrene. This soft-flowing styrene molding powder can be used in any standard injection, compression or extrusion machine. Put Lustrex Hi-Flow 55 styrene's work-saving, cost-cutting advantages to work for *you* today. It's ideal for thick section-pieces and deep-drawn applications. Perfect for packaging and food containers, pin-point gating and thin-wall applications where general-purpose styrene has trouble in filling.

For full information, write MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2908, Springfield 2, Mass.

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SERVING INDUSTRY...WHICH SERVES MANKIND

Tool Steels . . . . for Plastic Molds

Hugo G. Becker
Crucible Steel Co. of America
Syracuse, New York

THE tremendous growth of the plastics molding industry has presented some rather unique problems to at least one segment of the steel industry, the tool steel producers. Back in 1868, when John Wesley Hyatt discovered cellulose nitrate, at which time the founder mills of our company were producing tool steel, certainly no one in the tool steel industry ever envisioned that this infant, called plastics, would grow to be a very particular and demanding customer. Again in 1909, when Dr. L. H. Backeland introduced the phenolic resins, it is doubtful if anyone had any idea that 5 to 7 ton steel forgings would be needed within the next 45 years to meet the requirements of the industry started by these two pioneers.

From the moldmaker's viewpoint, a good mold steel would have the machinability of Bessemer screw stock, the heat treating stability of the air-hardening tool-steels, absolute cleanness, the polishing characteristics of the precious metals, and availability as in modern-day supermarkets. Since it is obvious no commercial production steel could meet all of these requirements, the tool steel industry undertook the problem of developing special tool steels designed for the plastics industry's usage.

In considering steels for plastic molds, it is important to review certain aspects concerning the production of a molded part. The design of the molded article is usually a compromise between engineering requirements, customer appeal, sales potential, and profitability. These four factors usually cause the mold to be built within certain restrictions. The most important of these is cost, which obviously affects profitability. Since the cost of the steel required is usually only a fraction of the cost of the labor involved, it behooves the moldmaker to exercise extremely good judgment in selecting steels. It is amazing to find the large number of moldmakers who look at their steel invoices and heat treating invoices with extreme care, and then disregard extra labor hours. For example, very few moldmakers ever consider the planning time of rough forged blocks as being applicable to actual steel cost. Table I will illustrate this fact rather clearly. Naturally, increasing the planer cost to $8 or $10 per hour, as in some instances, would increase the net per pound price even more. In addition, on sizes that exceed the moldmaker's planer capacity and have to be sent out for planing, very few moldmakers ever consider the cross-city or inter-city freight charges which can amount to one or two cents per pound.

From the practical viewpoint of the mold builder, the three factors of importance concerning tool steels for plastic molds are their production, distribution, and application. In other words, the tool steel the moldmaker requires is of no value to him until it is produced and inspected in accordance with plastic mold standards. Once the tool steel is produced, its value to the moldmaker is still nil, unless it is readily available in the size required. When the tool steel has been produced and made available, its value to the moldmaker is governed by the proper application of the steel within the limitations of its physical and mechanical properties. Therefore, we will discuss tool steels for plastic molds with these facts in mind.

Steel may be melted in a bessemer converter, an open hearth, or in an electric furnace. Each has its place in industry. The basic open hearth is a tonnage mill melting tool. In the hands of experienced melters, it is capable of close control and an excellent product is furnished to

TABLE I

Planing Costs On Rough Forged Blocks

Block Size (Finish Ground)	Est. Planer Time To Square	Planer Cost at $6.00/hr.	Excess Steel Removed in Planing	Est. Net Increase In Finish Ground Steel Cost
12 x 3 x 15	2.735 hrs.	$16.40	36 lbs.	19.0c/lb.
16 x 4 x 18	3.365 hrs.	$20.00	73 lbs.	13.5c/lb.
18 x 6 x 20	4.70 hrs.	$28.20	124 lbs.	11.5c/lb.
20 x 8 x 24	5.47 hrs.	$32.80	220 lbs.	8.9c/lb.
25 x 6 x 36	7.38 hrs.	$44.30	280 lbs.	8.7c/lb.
25 x 10 x 25	8.65 hrs.	$51.80	325 lbs.	7.9c/lb.
30 x 4 x 40	8.75 hrs.	$52.50	310 lbs.	10.2c/lb.
40 x 6 x 40	16.2 hrs.	$97.00	620 lbs.	6.5c/lb.

Note: All estimates plus grinding cost.

Hugo Becker

Figure 1: Modern Quantometer. A direct reading spectrographic instrument allowing complete chemical analysis including sample preparation in about 10 minutes.

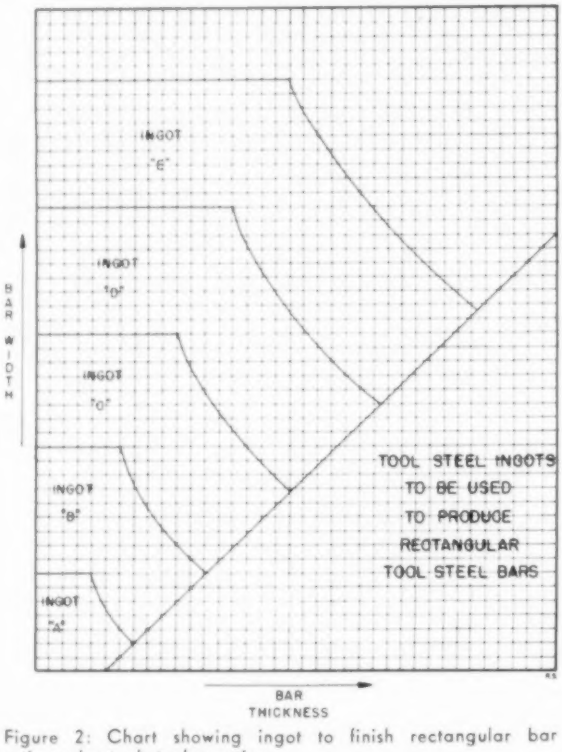

Figure 2: Chart showing ingot to finish rectangular bar ratio under tool steel practice.

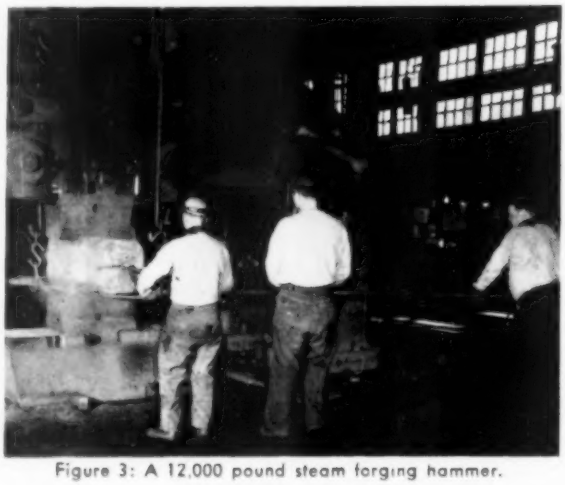

Figure 3: A 12,000 pound steam forging hammer.

many industries. Because of contamination from the heating atmosphere and inability to manipulate slags, however, it is necessary to limit the alloy content which can be added to the open hearth furnace. In fact, it is necessary to make some of the additions to the ladle during tapping. An electric arc furnace allows careful control of oxidation and reduction as well as of slag practice. This results in a more reproducible product with regard to analysis, as well as general cleanness. Tool steel melting is normal electric furnace melting, utilizing all of the known techniques and aids, to produce a high quality product. Because of the higher cost of melting and greater emphasis on quality in most tool steel melt shops, expensive aids such as immersion thermocouples for molten bath temperature measurements, and spectrographs for accurate chemistries can be used. Figure 1 shows a modern direct reading quantometer which allows the melter to have the analysis of the molten bath within minutes of its being sampled. Particular emphasis is given to ladle and mold cleanliness as well as to proper slag control.

In the melting and casting of steels, a prime factor, little known to those outside the steel industry, is of importance. This is the question of proper ingot design. To a great many persons, the word "ingot" just describes that thing from which we start. In the tool steel industry, however, ingot design is as exact a science as the design and gating of plastic molds. There are many types of ingots, such as straight side, tapered big end down, tapered big end up, square, round, fluted, etc. Ingot molds represent a compromise between sound metallurgical practice and the dictates of economics, concerning high rolling mill tonnage and low ingot mold cost. Tool steel ingot molds are normally designed to promote the greatest possible ingot soundness even at the expense of greater cost. Tool steel melt shops have higher ingot mold costs and shorter mold life to insure a high quality product.

In addition, another extremely important factor is the relationship of the type and size of ingot used to the shape and size of the finished bar, or forged block. Figure 2 illustrates this fact. For example, let us say a flat bar, 10" x 2" in cross-section, would be made out of Ingot A, and a flat bar, 20" x 4", out of Ingot D. While in commercial practice, Ingot D could also be applied to the 10" x 2", under tool steel practice, it could not be applied to this section even though it is physically possible for the size to be made from that ingot. Furthermore, in normal practice, different grades have distinctly different ingot to finished product relationships. It becomes fairly obvious that the greatest advantage any primary steel producing unit offers the consumer is their prime knowledge and control over melting practice, ingot design, and ingot application.

After tool steel ingots have been cast, they then must be worked at their proper temperatures in their plastic state to the size and shape of the desired finished product. This can be done by two methods, either by so-called single conversion or multiple conversion. Single conversion means the hot working of the steel from ingot to approximate finish size and shape in one continuous forging operation. Multiple conversion means an intermittent series of heating, forging, and cooling operations. In single conversion, the original ingot surface is removed after forging to final stage by some mechanical means, such as machining or grinding. In multiple conversion, this surface is removed at some intermediate cooling point, usually by chipping or grinding. The choice is usually dictated by the facilities available to the steel

In general, the lower alloy steels can be converted by either method, however, high alloy steels, such as the high speed steels, must be multiple converted. Neither method has any particular advantages, except that single conversion lends itself to high production when properly scheduled. Multiple conversion has the added risk of possible internal ruptures caused by repeated heating and cooling. In this instance, the steel producers have the advantage over other converting units in that they are fully aware of the steel's melting and hot working history.

Ingots can be hot worked by either rolling or forging. Rolling is strictly by multiple conversion, with the ingot being reduced to a billet and the billet being passed through sets of contoured rolls until the final round, square, or other standard shape is formed. Rolling only lends itself to the production of relatively small tool steel sizes. Tool steels for plastic molds are hot worked primarily by forging. Forging can be accomplished by means of a hammer or a press. Figure 3 shows a 12,000 lb. steam hammer. In hammer forging, multiple conversion is almost always used. Forging hammers are generally limited as to the size of the piece of steel they can convert and are usually limited as to the relatively smaller sizes, although they can be used with care for the larger sizes. Figure 4 shows a 1,500 ton forging press working a 7 ton plastic television mold forging. The piece of equipment behind the press is a 10 ton manipulator which handles the steel during forging. Presses are almost always used for producing relatively large forgings. They can also be used for small forgings, except that this is not usually practical because of costs. Presses can be operated by both single and multiple conversion methods. In a large number of cases, presses are used for the initial ingot breakdown of a multiple conversion. Needless to say, there are a large number of discussions concerning the relative advantages and qualities of forging by means of hammer or press. It should be noted that a forging hammer is a percussion piece of equipment delivering a sharp blow, whereas the forging press is a pressure instrument, applying a uniform squeeze. Nevertheless, one fact is known, all experienced forgers having both pieces of equipment will invariably choose the press over the hammer for all forgings possible, from quality, production, and cost viewpoints.

All steels contain gasses dissolved in them in the molten state. During solidification and during the subsequent cooling of an ingot, these gasses come out of solution and build up tremendous pressures within the solid steel. These pressures sometimes become so great in large forgings that small ruptures actually occur inside the steel. This condition is known as flake and is illustrated by the macro-etch shown in Figure 5. It may be prevented by cooling the steel so slowly that the gasses have an opportunity to diffuse out of the metal as fast as they come out of solution. A flake prevention treatment is expensive when done in a furnace, since the slow cooling must of necessity be continued down to temperatures in the neighborhood of 200°F., thus requiring excessive furnace times. Flake prevention treatments are standard practice with tool steels.

An inspection tool used in steel inspection is the macro-etch. A cross section of the original bar is cut and etched in an acid, usually hot hydrochloric. Voids, inclusions, or alloy rich or lean areas, are differentially attacked by the acid and are thus readily disclosed. Figure 6 shows macro-etches of satisfactory and rejectable qualities cut from forged bars of a plastic mold steel. If the surface being examined is polished and very lightly

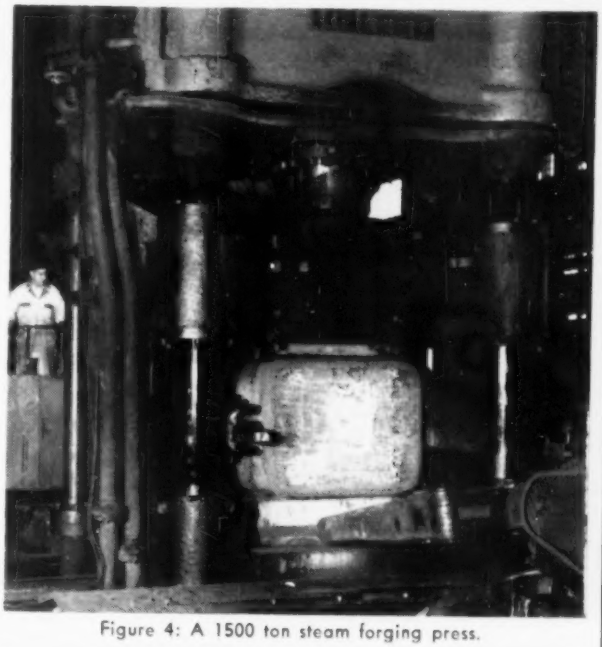

Figure 4: A 1500 ton steam forging press.

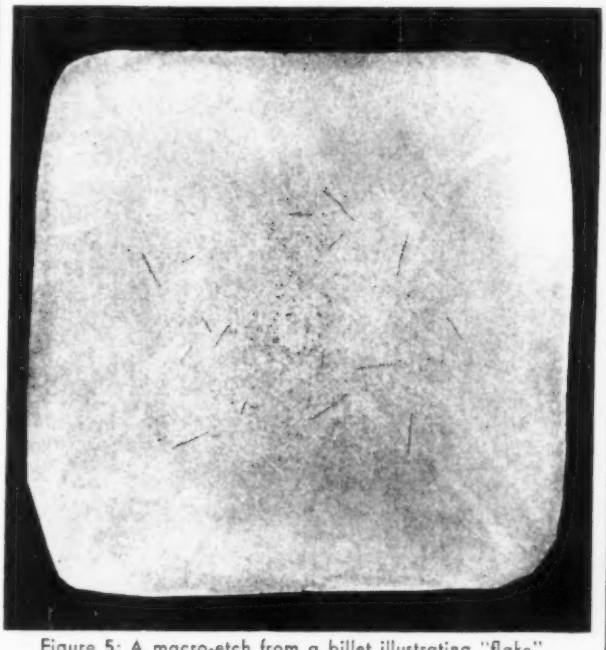

Figure 5: A macro-etch from a billet illustrating "flake".

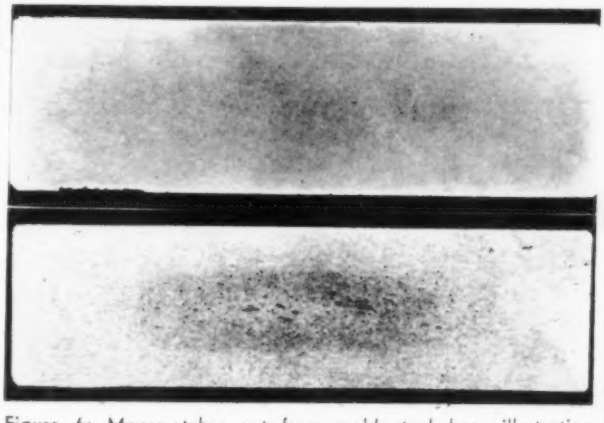

Figure 6: Macro-etches cut from mold steel bars illustrating satisfactory and unsatisfactory material.

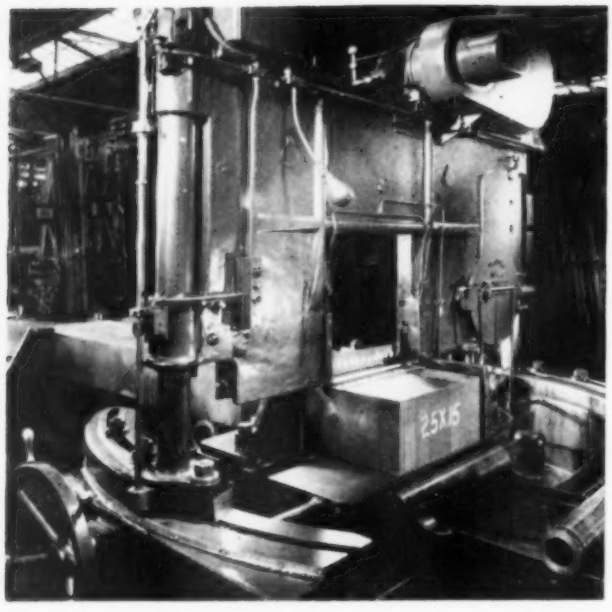

Figure 7: Standard 24" hydraulic hack saw shown with a bar of 25" x 15" mold steel ready for cutting.

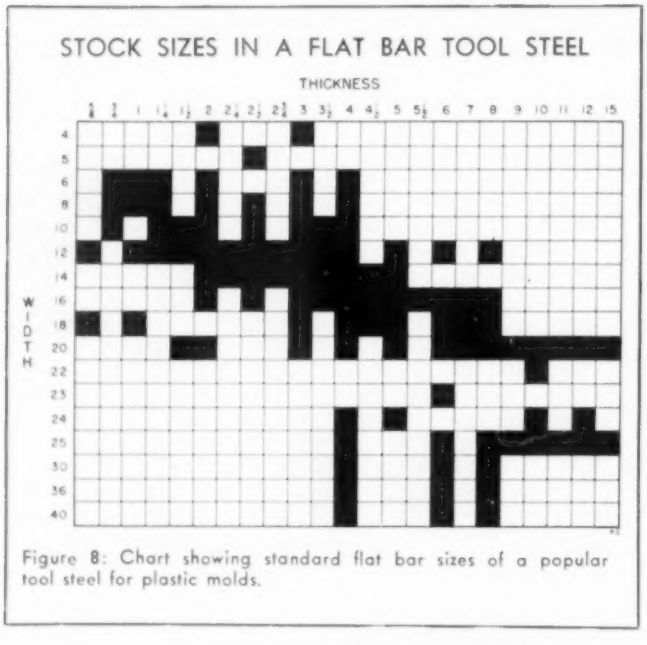

Figure 8: Chart showing standard flat bar sizes of a popular tool steel for plastic molds.

etched, it may be studied under the microscope. This is called a micro-etch and enables the trained metallurgist to see the grain of the steel and examine the structure. From this examination, he can make an educated deduction as to the prior history of the steel, as well as to observe such things as decarburization and cleanness.

The techniques described allow us to test steel at isolated locations and because a uniform practice has been used, we assume that the steel between test locations is of the same quality characteristics. To check this point, a Supersonic Reflectoscope is used. This is a tool, resembling radar, by means of which a sound wave is sent into the steel and the reflections are recorded on a screen. Normal sound steel results in a reflection of the opposite side of the bar being tested. If this reflection is reduced in magnitude, or if there is a new reflection, it means that there is an irregularity inside the steel. This may or may not be detrimental depending upon its nature. Interpretation of the indications seen on the sonic scope requires even greater experience than in the case of conventional radar, since minor characteristics such as grain size and orientation may give sonic indications. At the present time, sonic inspection is dependent almost entirely upon the skill and experience of the operator, so that sonic specifications are difficult, if not impossible, to reduce to writing. All of the inspection methods mentioned must be used and the results correlated. No few alone can suffice. Someone familiar with the end use of the product must evaluate all results and make a decision as to the suitability of the material for the end application.

The second important factor concerning tool steels for plastic molds is their availability to moldmakers after the steel has been produced. In general, the steel supplier must operate under the basic distribution hypothesis that when the steel for the cavity and force is ordered, the job is already a minimum of one day behind schedule. We will illustrate this fact by referring to Table II. It can readily be seen that the first person who can delay the timetable is the steel supplier. In some cases, he receives a larger portion of the blame for ultimate delays than is really his due.

Tool steels for plastic molds can be obtained either cut from warehouse stock bars, or forged to order. With this situation in mind, it becomes fairly obvious that availability immediately separates into two categories—relatively short times and relatively extended times for delivery.

First, let us discuss availability from warehouse stock bars. It is interesting to note the reactions of moldmakers in various parts of the country. In parts of New England, steel located 30 miles away is too far; in San

TABLE II

Operational Timetable for the Development of a Molded Part

	Deadline Date	Operation
1.	Conceive idea for part	No deadline set.
2.	Sketch part	No deadline set.
3.	Make part drawing	Vague deadline as details are worked out.
4.	Make mold drawing	Approximate deadline as details are worked out.
5.	Obtain mold quote	Vague to approximate deadline depending on the individual moldmakers quoting and on mold building backlog.
6.	Let mold contract	D-Day
7.	Obtain tool steel for cavity and force	D + a days.
8.	Deliver mold	D + b days.
9.	Sample mold	D + c days.
10.	Begin production	D + d days.

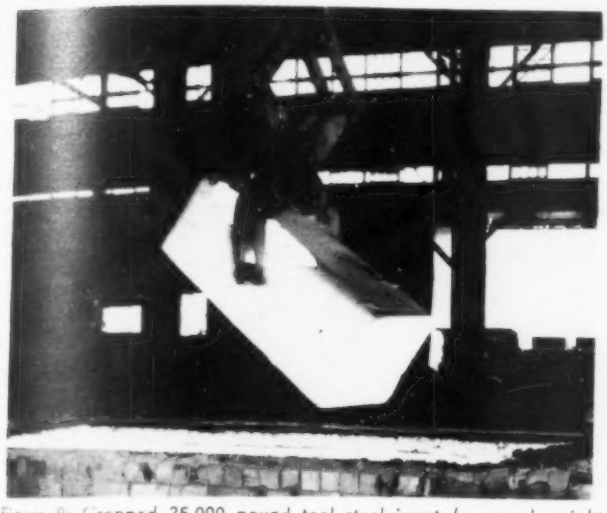

Figure 9: Cropped 25,000 pound tool steel ingot (cropped weight 18,000 lbs.) being removed from forge heating pit preparatory to forging operation for 7 ton television mold forging.

Francisco, steel located in Los Angeles is only 450 miles away, practically in the shop.

The handling of stocks of tool steels for plastic molds in warehouses presents some important problems. Adequate warehousing floor area must be available. Adequate crane facilities also should be available. Proper sawing facilities are required. Hack saws capable of cutting 20 to 25 inch widths are necessary. Figure 7 shows a hydraulic hack saw ready to cut a 25 x 15 inch bar of tool steel for a plastic mold. For the benefit of those moldmakers who wish to rush out and order one of these saws, let us point out that such a saw, installed and ready to operate today, will cost about $25,000 to $30,000.

In further consideration of warehouse stocks, let us review standard stock sizes. Figure 8 shows the complete range of flat bar sizes stocked in a rather popular tool steel grade for plastic molds. Regardless of what stock sizes are maintained, every effort should be made by mold designers and moldmakers to select those sizes stocked, as in this way the obtaining of steel can be expedited. In other words, select combinations of widths and thicknesses that appear readily obtainable and don't specify odd sizes. Someday, standardization of mold sizes may be effected to everyone's advantage.

The other means of obtaining tool steel for plastic molds is to order special forgings. Special forgings present peculiar problems. First, their deliveries are long compared to warehouse stock sizes. Second, special forgings reach final inspection just before they are ready to ship. This means that a rejection can double the already extended delivery time. At this point, it is important to note that no steel supplier ever rejects a special forging just to upset the moldmaker's schedule. Actually, the percentage of rejected special forgings is no different from the percentage rejection of bars intended for stock. Only the importance of the time element may make it seem so. It is important to note that as forging sizes and weights increase, delivery times will increase. For those sizes requiring ingots weighing 10,000 to 25,000 pounds for production, it must be realized that masses of steel, such as these, cannot be heated properly to forging temperature in hours, but rather require days. For example, the successful production of a 14,000 pound television mold forging, illustrated in Figures 9 to 16, required that the cropped 25,000 pound ingot be preheated for

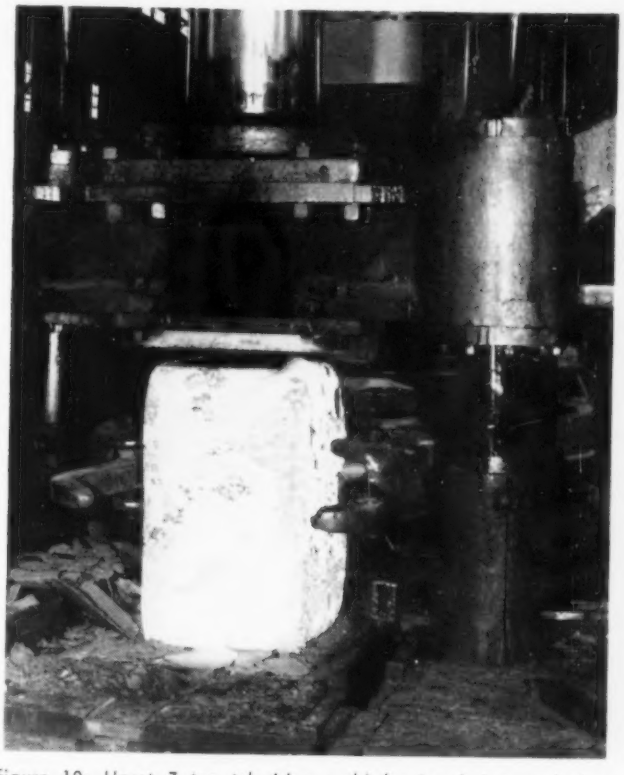

Figure 10: Upset 7 ton television mold forging being worked to final shape on 1500 ton forging press. Note heavy scale representing 900 pound scale loss during heating and forging operations.

Figure 11: Rough planing 7 ton television mold forging. Note steel chips representing 2300 pounds of steel removed in planing.

three days, then raised to forging heat in three days, and forged and reheated and reforged for a period of four days—in other words, ten days elapsed for the forging operation alone. As an example of the effect of these operations, it is interesting to note that a 900 pound scale loss was incurred during the heating and forging. The forging was slow cooled for flake prevention over a seven day period and then annealed, which required another seven day period. In other words, 24 days were the operational requirement under tool steel practice to produce the rough forging. Since it is not always possible to start preheating the moment the order for the forging

Figure 12: Finish planed 7 ton television mold forging 40" x 28" x 43" weighing 13,960 pounds.

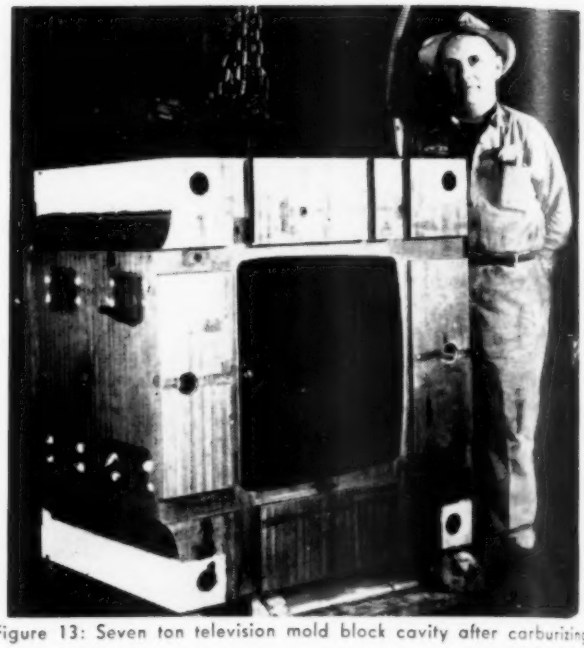

Figure 13: Seven ton television mold block cavity after carburizing

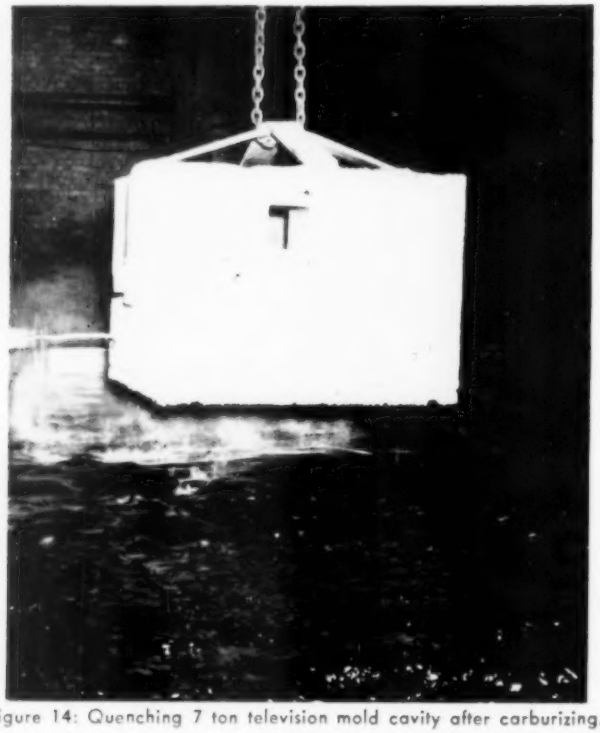

Figure 14: Quenching 7 ton television mold cavity after carburizing.

Figure 15: Molding television cabinet.

STORY OF A 7-TON MOLD FOR A T.V. CABINET

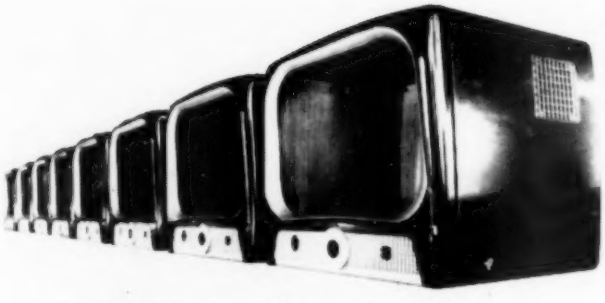

Figure 16: Television cabinets produced in large mold.

is received, it can readily be seen that extended deliveries must be counted on. Granted, all sizes over and above those which may be cut from stock sizes must be forged special. Therefore, it behooves every moldmaker, for his own benefit, to allow for the extended forging delivery times required. In addition, remember that forging deliveries quoted on the first of the month, based on existing situations, may change when ordered two or three weeks later, due to the then present situation.

The proper application of tool steels for plastic molds is the third factor of importance. Before discussing individual grades, certain fundamental facts must be understood.

All individual grades of heat treatable steels have particular combinations of mechanical and physical properties. By mechanical properties is meant the combination of tensile and yield strengths, elastic limit, ductility, toughness, and hardness; and such allied properties as hobability and machinability. These properties can be changed within certain fundamental limits by changing the conditions of heat treatment. These characteristics hold true for all heat treatable steels.

In addition, heat treatable grades of steel have certain combinations of physical properties which are inherent and cannot be changed by heat treatment. These properties are basically controlled by the chemical composition of the steel and the melting practice followed.

Steels for cold hobbing must be in the fully annealed dead soft condition. The steels shown in Table III are the types most predominant in present day usage.

The choice of any steel for hobbing must be based on the relationship between the hobability of the steel and the safety of the hob. In this respect, hob and cavity should be designed to eliminate thin sections where possible. In some instances, it is preferable to hob the cavity and then machine-out the thin sections.

Since all of the steels in Table III are of the very low carbon type, they must be carburized before hardening to obtain a high attainable hardness on the surface. Therefore, the hardenability of each steel is the measure of its resistance to molding pressures, and also of its hobability.

The selection of a steel for the master hob is of an importance second only to the selection of the hobbing steel. Master hob steels have certain prime characteristics. These are as follows:

1. High strength in compression and tension.
2. High wear resistance after heat treatment.
3. Minimum movement in heat treatment.
4. Minimum susceptibility to scaling in heat treatment.
5. Good machinability as annealed.

The steels listed in Table IV are those normally used in present day practice.

Steels for machined mold cavities and forces are the most important of all steels used by the plastic molding industry. The requirements of top quality steel vary with the type of molding to be done. However, maximum cleanness is required in any case. In addition, it is of utmost importance that the steel in its final heat treated condition take a mirror finish.

The steels most widely used for machine-cut mold cavities and forces are listed in Table V.

It should be noted that mold sizes spread over a tremendous range. Compression molds range from the very small to large television cabinet molds requiring cavity block forgings weighing 14,000 pounds. In the same manner, injection molds range from the small to molds requiring planed square cavity and force blocks weighing 7000 pounds each, having dimensions of 44" x 7" to 66" shown in Figures 17 to 20. One other important consideration is the mold hardness that is required. Most compression molds require cavity surface hardness at a relatively high level to resist the abrasive and erosive action of thermosetting resins. On the other hand, most injection molds do not require high cavity surface hardness levels other than to resist abuse due to negligent operating conditions and to provide resistance to abrasion at cut-offs. However, injection molds do require a certain amount of compressive strength at the lands to resist the high clamping pressures and to resist flash sinking.

The proper design of mold wall thickness is important when considering the proper application of steels for plastic molds. In this connection, due consideration must be given to that physical property known as Young's modulus of elasticity. It is defined as the ratio, within the limits of elasticity, of the stress to the corresponding strain. A great number of persons have the idea that heat treatment will improve stiffness (or reduce flexibility). This is not so.

Under the same conditions of support, cross-section, and relatively light loading, all steels will bend the same

TABLE III
Tool Steels For Hobbed Molds

Steel #	Type	Carbon	Manganese	Silicon	Nickel	Chrome		Vanadium
1-H	Low Carbon Iron	.07 max.	.20					option to .10
2-Ha	Low Cr-Ni-Mo Alloy	.07 max.			.55	1.35	.20	
2-Hb	Medium Cr Alloy	.10 max.	.30	.20		2.30		
3-H	Air Hardening	.10 max.	.30	.20		5.00	.50 1.00	option to .25

TABLE IV
Tool Steels For Master Hobs

Steel #	Type	Carbon	Manganese	Silicon	Chrome	Moly.	Vanadium	Tungsten
H-1	2-¾ W, 1-¼ Cr Shock Resisting	.50		.75	1.25		.20	2.75
H-2	Non-Deforming	.90	1.25		.50			.50
H-3	Air-Hardening	1.00	.40		5.25	1.15	.40	
H-4	High C—High Cr Air Hardening	1.50			11.50	.80	.20	

TABLE V
Tool Steels For Machine-Cut Molds

Steel #	Type	Carbon	Manganese	Silicon	Nickel	Chrome	Moly.	Van.	Tungsten
1-Ma	1Cr-Mo Low Alloy	.33	.75	.50		.80	.25		
1-Mb	1Cr-3½Ni Low Alloy	.10	.40		3.50	1.60			
1-Mc	1Cr-½V Low Alloy	.45	.70			1.00		.20	
2-M	Non-Deforming	.90	1.25			.50			.50
3-M	Cr-Mo-V Hot Work	.40		1.05		5.00	1.35	1.00	
4-M	Air-Hardening	1.00	.40			5.25	1.15	.40	
5-M	Stainless	.30				12.00			

A BIG INJECTION MOLD

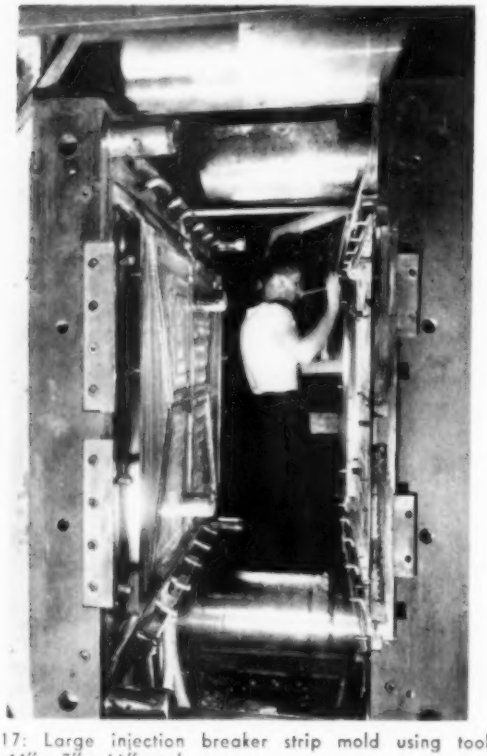

Figure 17: Large injection breaker strip mold using tool steel forgings 44" x 7" x 66" each.

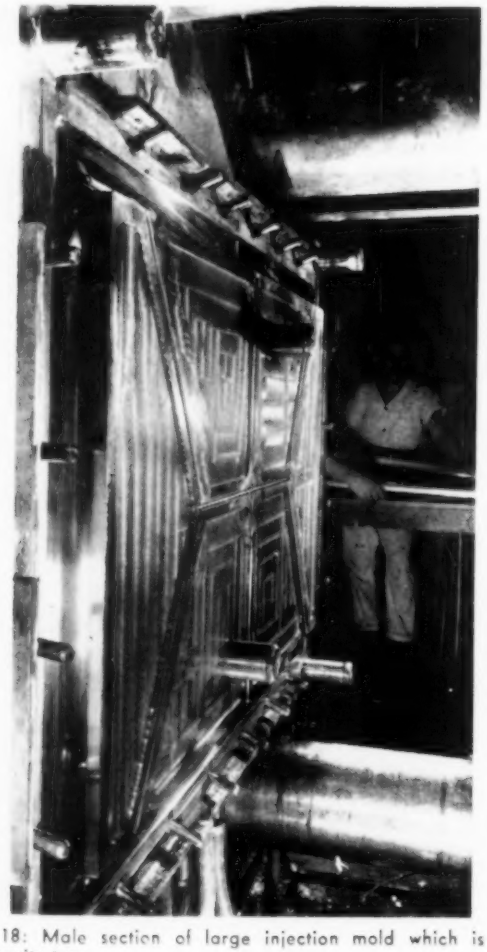

Figure 18: Male section of large injection mold which is of inverted cavity type.

amount and return to their original position upon release of load. This is true provided the steels are not stressed above their elastic limits.

As a practical example, take a small sewing needle and an awl. The needle is flexible and will bend and spring back under hand pressure, whereas the awl is very stiff. The needle and the awl are produced from steels of the same approximate analysis and are heat treated to the same hardness. Another example would be to compare 1/32" and 1" high speed steel twist drills. The small drill will bend and spring back under hand pressure, not so with the large drill. Both drills are the same grade of high speed steel and are heat treated to the same hardness.

The formula for the deflection of a beam freely supported at both ends and loaded in the center is shown in Figure 21. This formula holds true for all materials up to their elastic limits. Since the modulus of elasticity is practically the same for all steels, it can be seen that under identical conditions of loading, the value to the right of the "equal" sign becomes a constant. Therefore, the deflection or stiffness is directly controlled by the dimensions of the cross-section.

In design, the usual factor of safety allowed is such that the metal is stressed below its elastic limit. Composition and/or heat treatment can be used to raise or lower the elastic limit, but cross-section and conditions of loading control flexibility.

As a practical example, let us consider an injection mold, hardened to about 32 Rockwell C, which flashes in operation due to underdesign. Heat treating this mold to 40 Rockwell C will not stop the flashing, but only decrease the sinking in of the mold parting surfaces. Flashing can only be eliminated by increasing the mold section or by decreasing the stresses applied.

Probably, heat treating is the most maligned of all metallurgical processes. Invariably, most problems oc-

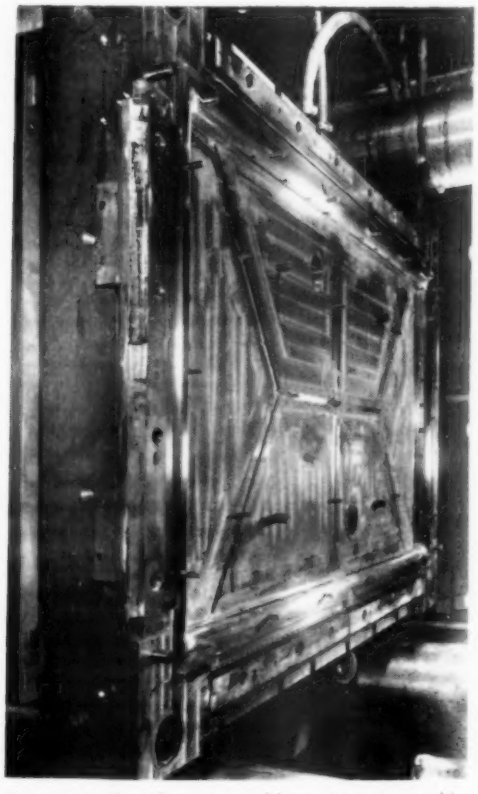

Figure 19: Female section of large injection mold

counter by all machine men are blamed on those "so and so" at the heat treating shop. From a practical viewpoint a great majority of these problems could be prevented if the heat treaters were considered partners in the production of quality molds, rather than necessary evils.

The biggest bugaboos to the moldmaker are size change and distortion. Briefly, all heat treatable steels have a size change during the hardening treatment, the reason being that the martensite formed (which results in hardness) has a different density than the prior annealed structure. Therefore, since the mass or weight must remain constant, the dimensions must change. Size change, properly controlled by means of steel composition and proper heat treatment can be eliminated as a problem. Distortion, however, is a problem which requires some practical cooperation among all parties. Just picture a large chunk of mold steel sitting on a bench in perfect contentment with the world. It has no internal problems, such as unequal stresses, as these have been neutralized before the block was shipped. Then, the moldmaker deliberately hogs out a large gaping hole in one side of the block. Not satisfied, he proceeds to bore holes in each corner and then to drill other holes throughout the length and width of the block. Sometimes he even cuts holes for slides and cores in the block. Finally, the poor block, which now just a shadow of its former self, is ready for heat treatment. The block is no longer free of unequal stresses, since stresses have been induced during the machining operations. The levels of these stresses are proportional to the skill of the moldmaker and the practice followed. When the block is heated up for hardening, these stresses tend to relieve themselves. Sometimes, they are so great that before they are relieved, they exceed the elevated temperature strength of the steel at some point weakened by excessive stock removal and so cause distortion. Therefore, a special stress relieving treatment is always recommended by the steel producers and the heat treaters before final machining. However, it is sad to state that most moldmakers agree that stress relieving is most beneficial and then bypass the treatment under pressure of time.

Compression molds generally must be carburized to raise the carbon content of the mold surface so that a relatively high surface hardness can be obtained. There are good and bad carburizing practices, which will vary from grade to grade. In other words, the treatment suitable for some stamped parts of SAE 1010 will not be suitable for a tool steel having a medium alloy content. Figure 22 will illustrate this factor very strongly. The microstructures shown on the left marked "Optimum" were made from samples of a popular tool steel for plastic molds which had been given the preferred carburizing heat treatment prescribed by the steel producer. The lower sample was given an additional deep freeze treatment to study its effect. The microstructures on the right, marked "Overheated", were given the carburizing heat treatment usually used for commerical SAE 1010 parts. The lower sample was also given an additional deep freeze treatment. The right hand structures would be metallurgically described as a mixture of tempered martensite (the black structure, which is hard) and retained austenite (the white structure, which is soft). Obviously, such a surface structure would present problems in polishing, as the soft material would tend to pull out, forming the ever recognizable "comet tails". The microstructure in the center is that of a plastic mold whose face was uniformly covered with "comet tails". A

(please turn to page 43)

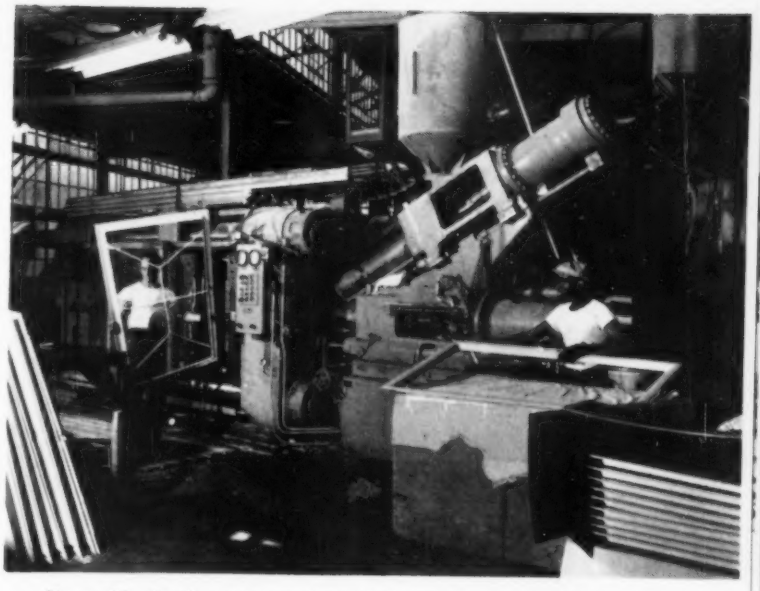

Figure 20: Breaker strip produced in large injection mold.

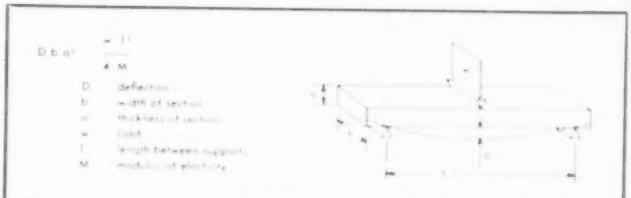

Figure 21: Formula illustrating the relationship between the deflection of a simple supported section in relation to a cross-section and modulus of elasticity.

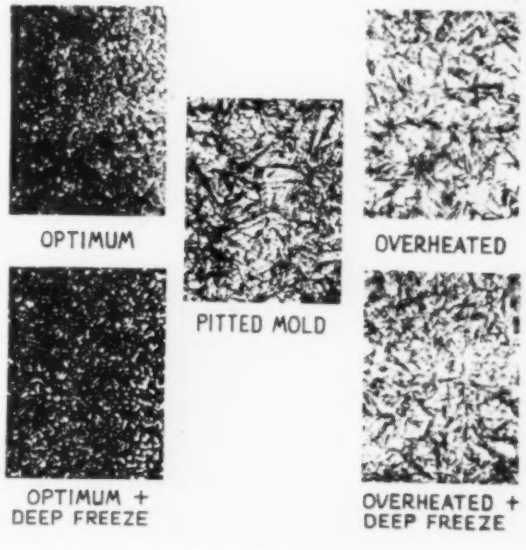

Figure 22: Composite photograph of micro-structures illustrating the effects of overheating in carburizing of a popular mold steel to produce retained austenite.

The Normal Frequency Distribution

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This article is the second in the series "Statistical Quality Control for the Plastics Molder," written for the Quality Control Committee of the SPE under the chairmanship of L. M. Debing.

The series is written for the molder who wants to use S.Q.C., and begins at the fundamental level, with special attention to clarity and specificness.

INTRODUCTION

In any production operation it is never possible to manufacture two things exactly alike; it is the realization of this fact that makes possible the development of the science of Statistical Quality Control. The existence of variability, and its underlying causes were covered in the preceding article of this series. It was shown that variations in measurements taken on injection molded pieces could be shown to form definite patterns when plotted in the form of frequency histograms. By making use of these patterns of variation obtained over a period of time, it was possible to compare the behavior of a process to its expected performance, and hence to determine what, if any, corrective action was required for better quality.

HISTORICAL BACKGROUND

The tendency in collected data to form these definite patterns was noted in the eighteenth century by the men who first developed the theory of probability. They also noticed that as the number of observations or measurements increased, and the scale of measurement became more and more sensitive, the plotted histograms more closely approached a smooth curve, as indicated in Figures 1 and 2.

Further study indicated that a very large majority of the frequency histograms plotted had certain characteristics in common: they were relatively symmetrical, the greatest number of observations were found in the center of the scale, and fewer and fewer data points occurred as the distance from the center increased. When the mathematicians tried to tie all these things together in one package, they found that they could describe most of these observed distributions of data by a certain smooth curve, which could be defined in mathematical terms. Later, when the same approach was used in industry it was found that measured data on the output of many production processes could be described by this very same smooth frequency distribution curve.

THE NORMAL FREQUENCY DISTRIBUTION

It was Gauss, back in 1803 who first decided that since so many collections of data from many varied sources followed the curve of which we have been speaking, there was something wrong with any data that did not behave in this manner. Therefore, he tagged the frequency curve the Normal Curve of Errors, or the Normal Frequency Distribution, a name which is in use today.

All of this would be only of passing interest if it were not for the fact that mathematical analysis of data making use of the Normal Frequency Distribution has enabled people to obtain much more information than would be possible otherwise. For example, by analyzing a process which has been found to fit the Normal Distribution curve, it is possible to predict with a good degree of certainty, what percentage of the measurements will fall between certain values on the scale. The mathematics have been worked out for us in great detail, so that with relatively simple calculations we can determine whether a process is behaving as it should.

Let's take a look at this Normal Frequency Distribution and see what makes it tick. Its relationship to the histogram is shown in Figure 1. To completely define the curve, we have to have some idea of:

a) Its level—where is it located on the scale of values?
b) Its dispersion—how far out along this scale does it spread?

There have been many ways found for expressing level and dispersion. Some are better than others, but for our purposes we will consider orly those which have been found to be the most effective.

The most effective way of measuring or defining the level of a distribution is the *average*, or *arithmetic mean*. This is obtained by adding up all of the values of the individual measurements and dividing this by the num-

Figures 1 and 2 illustrate a typical quality control histogram and show the theoretical "normal distribution curve."

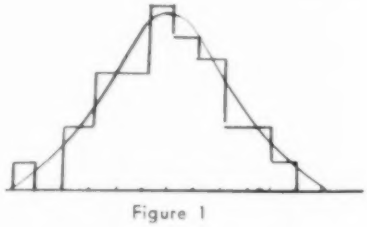

Figure 1

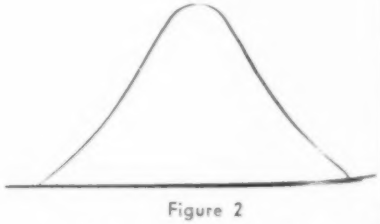

Figure 2

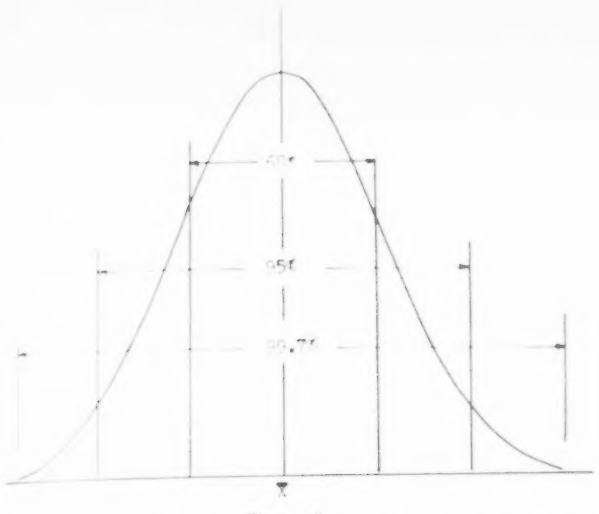

Figure 3

Between ± 1 standard deviation from the mean we expect to find 68% of all observed values.
Between ± 2 standard deviations from the mean we expect to find 95% of all observed values.
Between ± 3 standard deviations from the mean we expect to find 99.73% of all observed values.

number of measurements taken.

The most effective way of expressing the dispersion of a distribution is by using the *standard deviation*. This is defined as "the square root of the mean of the squares of the individual deviations from the average". To obtain the standard deviation, the following procedure may be used.

1. Determine the *average* of all the data observed.
2. Determine the *difference* between each observation and the average.
3. Square each of these *differences*.
4. Add all these squares together.
5. Divide the sum of these squared differences by the total number of data points.
6. Take the square root of this result.

An interesting point about using the average and standard deviation in describing a collection of data is that for any given average and standard deviation one and only one Normal Frequency Distribution curve can be drawn.

The standard deviation is usually expressed by the Greek letter σ (sigma), and the arithmetic mean by the symbol $\overline{X}$ (X-bar).

TIE-IN WITH INDUSTRIAL PROCESSES

It may well be asked at this point "How can we make use of this mathematical curve in controlling product quality?" In order to answer this, let us first cover the relationship between the data collected from a process, and the Normal Frequency Distribution curve calculated from the data.

1. The *mean* or *average* of the frequency curve, on the scale of values is equal to the *average* of all the collected data obtained.
2. The *height of the curve* above the base line represents the relative frequency with which the corresponding measured value would occur in a very large number of measurements.
3. The *area under the curve* between any two given measurements represents that percentage of the measurements which will fall between the two stated values in a very large number of observations. The mathematics have been worked out for us, and tables have been published to assist in using this information. Most of the books listed at the end of this article contain these tables.
4. The *standard deviation* measures the expected spread of measured values, and the relationship between the standard deviation and the area under the curve is shown in Figure 3.

In controlling the quality of a production operation we make use of the values given in the preceding section. In general, as long as our observed values conform to the expected proportions, we can assume that the process is operating as it was when the original calculations were made. Any drastic shift in these percentages indicates a change in the process, and it is to our advantage to investigate and maintain this shift if it represents better quality; to eliminate the causes if it represents poorer quality.

Since the probability of measurements falling between ±3 standard deviations is practically 100% provided no changes (intentional or otherwise) are made in the process, the values corresponding to ±3 sigma are called the natural tolerance of the process. Hence when we observe that a measured dimension on a molded piece averages 0.025" when the molding operation is in a good state of control, and calculate the standard deviation at 0.001", we call 0.025 ±3 (0.001") the natural tolerance of the dimension. We expect 99.73% of all pieces to fall between 0.022" and 0.028". Another term often used for these limits are the three sigma or control limits, more of which will be seen in a later article.

When a dimensional tolerance is specified on a molded piece, it is advisable to determine the natural tolerance of the molding operation. If this natural tolerance is narrower than the specifications, we are in good shape. If the natural tolerance is wider than the specifications, then a certain amount of scrap will be produced, no matter how carefully we operate. Figure 4 shows several

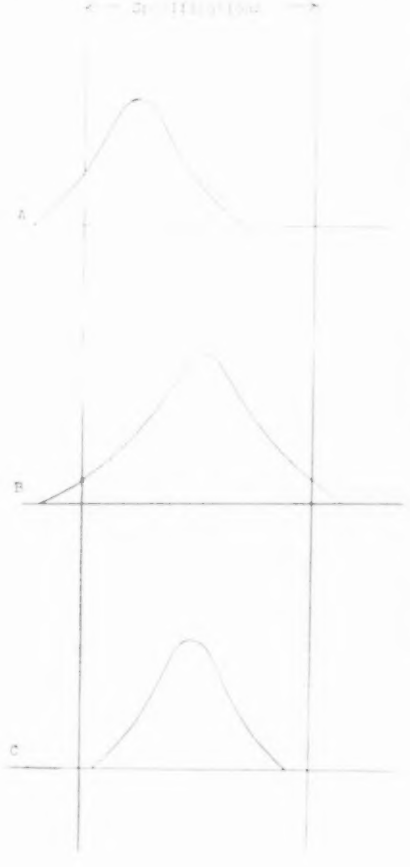

Figure 4

Process level too low. Adjustment should be made to produce heavier pieces.

Specs too narrow or process variation too great. Worn equipment, sloppy molding techniques possible causes.

Desirable relationship between specifications and process.

operations in which the Normal Frequency Distributions are compared with the tolerances and indicates the type of action which would be required for optimum quality control.

A CASE HISTORY

A typical example of the use of the Normal Frequency Distribution in a production process follows. In an operation where polystyrene wall tile was being molded in an 8 cavity die, it had been observed over a period of time that the gauge measured to the nearest 0.001 inches ordinarily built up to a Normal Distribution when the process was operating as it should. In the instance in question, a series of observations was taken over a period of time on pieces taken from a single die, to investigate the belief that this particular die was in need of repair. These measurements were plotted as a frequency histogram, and gave the pattern shown in Figure 5.

.098	X
.097	X
.096	XX
.095	XX
.094	XXXXX
.093	XXXXXX
.092	XXXXXXXXX
.091	XXXXXXXX
.090	XXXXXXXXXXXX
.089	XXXXXXXXXXXXXX
.088	XXXXXXXXX
.087	XXXX
.086	X

Fig. 5

The specifications on this piece called for an average of 0.090, with tolerances of ±0.005 maximum.

The mean and standard deviation for these data were calculated and found to be as follows:

Mean = $\overline{X}$ = 0.0907

Standard deviation = 0.00253

The three sigma limits on the dimension measured were ±3 (0.00253) or ±0.0076, hence the natural tolerance was 0.0831 to 0.0893. Comparing this against the desired limits of 0.090 ± 0.005, it can readily be seen that the variation of the process was greater than desired. Even without such algebraic analysis, the distribution appeared skewed or slanted toward higher readings. These were undesirable because they resulted in a costly hand filing operation to enable them to meet other dimensional tolerances.

After a thorough investigation of possible causes of the excessive variation, it was found that installation of a microswitch pressure drop off system to the injection press achieved the desired result. In a subsequent distribution analysis, the average was found to be 0.0905 inches, and the standard deviation was 0.0020. Shown in Fig. 6, the resultant distribution was less skewed and seemed very normal indeed. Although ±3 limits slightly exceeded the old ±.005 specification, the thick, costly pieces were eliminated and there appeared no further need for improvement of the operation. A more realistic specification of .089 ± .007 was adopted.

Although tiles flooded sufficiently to require trimming had accounted for less than 5% of former production, the final inspection had to be geared to find them. With these oversize tiles eliminated, combined inspection and trimming labor costs of $1.15 thousand tiles were reduced while product quality improved.

OTHER DISTRIBUTIONS

In discussing the properties of the normal frequency distribution we have covered the underlying mathematical basis for most production operations where the data represent a measured property. Properties which can be measured are called *variables* and include such things as dimension, tensile strength, chemical properties, electrical resistance, etc.

In some processes there are certain quality characteristics which are not measured. For example, we may be interested in whether a particular dimension is between certain limits or outside of these limits. We may be interested in whether a certain item is considered good or bad as regards a certain visual standard. The quality decision which we are making on the individual item is merely a yes or no decision; is the item good or bad, acceptable or defective? These quality characteristics are called *attributes*.

It is difficult to see at a glance how the properties of the normal frequency distribution can be applied to this type of quality characteristic. In fact it is difficult to see how this type of property can build up any kind of frequency distribution at all. Supposing, however, we consider a fairly large number of individual items as a unit or production and by a go-no-go type of inspection determine how many of these individual items are good and how many are bad. The percentage, or fraction defective, thus obtained can be used as a quality measurement and a series of such observations will eventually build up into a particular type of frequency distribution. The type of distribution encountered here is called the *Binomial Frequency Distribution*. The mathematics of this distribution has been given considerable attention and tables are readily available (see references at the end of this article).

Under certain conditions the Binomial Distribution conforms very closely to the Normal Frequency Distribution. For fairly high values of percent defective (20 to 80%), or where the number of items inspected is quite large, the normal distribution can reasonably be substituted for the Binomial frequency distribution.

A special case of attribute inspection is that in which the number of defects in a certain unit of production is counted. For example, the total number of dirt specks on a piece of wall tile might be considered as a

(please turn to page 42)

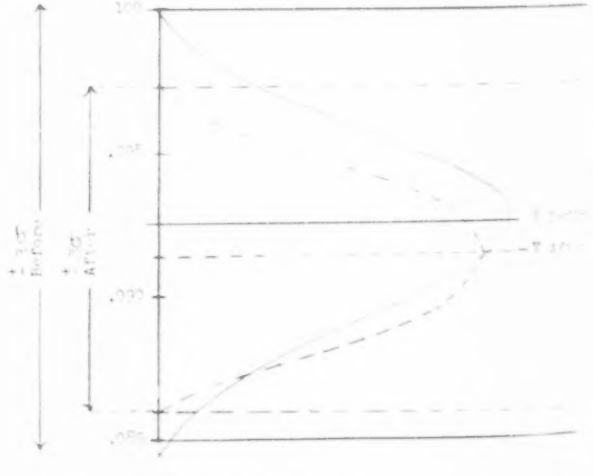

Figure 6: Distribution of parts variation before and after correcting molding process for plastic tile. With known limits of variability, realistic specifications can be made.

Thermal Degradation of Polymers During Molding Part II. Experimental Study

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INTRODUCTION

In part I of this series[1] dealing with the thermal degradation of polymers during molding we presented a simple mathematical analysis of the injection molding process for the case where part of the charge is returned to the cylinder in the form of ground scrap. In this part of the work we present some pertinent experimental results.

These are concerned with **(a)** the extent of polymer degradation during molding both as a function of the number of molding cycles and the cylinder temperature and **(b)** some preliminary results of **(a)** on selected physical properties. The properties studied were the viscosity and Izod notched impact strength of the molded polymer.

EXPERIMENTAL METHODS

A Moslo three-quarter ounce vertical injection molding machine was used for the experiments. A number of moldings were made for each reading and for the impact strength measurements an average of thirty readings was taken as the value for each number of cycles. An A.S.T.M. impact test piece but with a molded notch was used for all the molding experiments. Specific viscosities were measured at 1 gram per 100 cc. toluene concentration at 20 ± 0.01°C. For the initial and final values the intrinsic viscosities were measured.

The moldings and the virgin material were ground for each experiment. A small initial drop in viscosity was found on grinding the virgin granules but no measurable drop was observed on grinding the sprues and moldings. The molding conditions were standardized at 30 seconds in the cylinder (cycle time) and 1400 p.s.i. pressure.

The total charge in the cylinder was 20 grams, on molding this gave a molding of 16.2 grams, a residue of 0.4 grams and scrap of 3.4 grams. This leads[1] to a value of 0.18 for "a".

The continuous heating experiments were carried out in a number of glass tubes immersed in a Fluorlube bath maintained at the necessary temperature. The materials used in this study consisted of two commercial samples of polystyrene. Koppers Type 7X and Koppers modified (high impact strength) and one sample of commercial cellulose acetate, (Hercules). Izod notched impact strengths were determined on the Koppers modified polystyrene and the cellulose acetate.

RESULTS AND DISCUSSION

The results of the specific viscosity measurements on samples of molded polystyrene (Koppers Type 7X) taken at different number of molding cycles at two different temperatures are shown in Table I:

Table I
Specific Viscosity of Molded Polystyrene Type 7X

No. of cycles	Specific viscosity $\bar{\eta}$ exp (n) Molded at 460°F.	Molded at 560°F.
0	1.294	1.294
1	1.195, 1.195	1.161
2	1.177, 1.174	1.155
3	1.165, 1.171	1.141
4	1.160	1.131
5	1.160	1.136
6	1.180	1.146
7	1.182, 1.170	1.134
8	——	1.143

This data gives a measure of the extent of degradation of the polystyrene sample with the number of moldings and as would be expected, as the temperature is increased so is the extent of degradation although the difference across the 100°F. range of our experiments is fairly small. The total degradation after seven molding cycles was determined from a comparison of the intrinsic viscosity of the molded sample with the intrinsic viscosity of the original, unheated polystyrene using the Staudinger-Mark relation (2),

$$M = 167{,}000\,[\bar{\eta}]^{1.7}$$

The extent of degradation after seven moldings, $\left[1-\left[\frac{M}{(M)_0}\right]\right]$ is 7.5% at 460°F. and 13.6% at 560°F.

In order to compare the experimental degree of degradation determined from the viscosity with the statistics of degradation in molding worked out in Part I[1]

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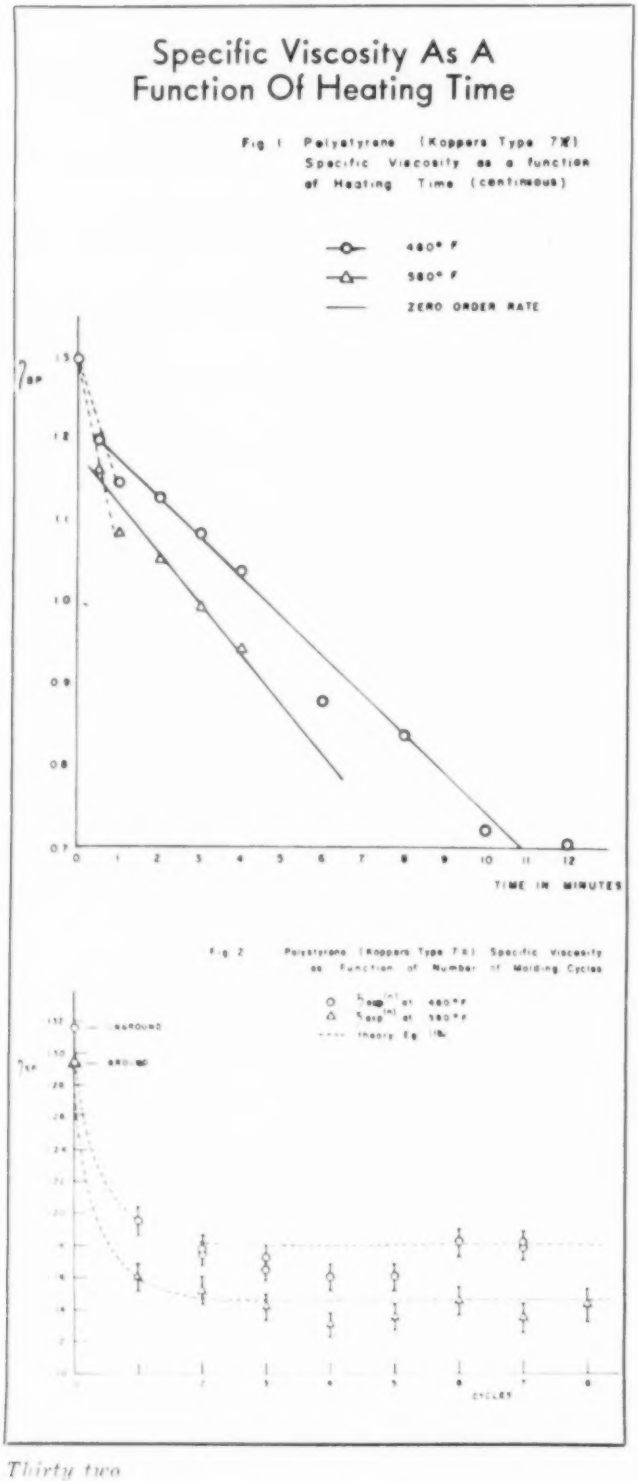
[1] *H. L. Frisch and V. T. Stannett, Soc. Plastics Eng. J., Vol. 10, No. 1, January 1954, pp 16-17.*

[2] *F. R. Mayo, R. A. Gregg and M. S. Matheson, J. Amer. Chem. Soc. 73, 1691 (1951)*

it was necessary to study the thermal degradation of the same samples of commercial polystyrene during the continuous heating experiments. This was measured by the specific viscosity of the sample as a function of the heating time, $\bar{\eta}sp$ (t), which is plotted in Fig. I, for the two temperatures used in the molding experiments. Using the theory worked out in Part I, the average specific viscosity of a polymer sample having passed through a total of n molding cycles $\bar{\eta}$ (n) is

$$\bar{\eta}(n) = \sum_{i=1}^{n} \bar{\eta}_{sp}(i\bar{t})\, W(i,n)$$


Specific Viscosity As A Function Of Heating Time
Fig 1 Polystyrene (Koppers Type 7X) Specific Viscosity as a function of Heating Time (continuous)
480° F
580° F
ZERO ORDER RATE
TIME IN MINUTES
Fig 2 Polystyrene (Koppers Type 7X) Specific Viscosity as Function of Number of Molding Cycles
theory Eq (1b)
CYCLES

where $\bar{\eta}sp$ ($i\bar{t}$) is the experimental specific viscosity of a continuously heated sample of polystyrene (polymer), heated for a time $t = i\bar{t}$; $\bar{t}$ is the molding cycle time, and w(i, n) is the fraction of i-fold heated (molded) material in the molded product after the sample has undergone a total of n molding cycles. The last quantity is related to the function u(i, n) defined and tabulated in reference (1):

$$w(i,n) = u(i-1, n-1),$$

and thus Eq. (1a) becomes

$$\bar{\eta}(n) = \bar{\eta}_{sp}(n\bar{t})\, a^{n} + \sum_{i=1}^{n-1} \bar{\eta}_{sp}(i\bar{t})\, a^{i-1}(1-a)$$

where

$$a = q + p(1-q),$$

with q the fraction of residue left in the cylinder and p(1-q) the fraction of scrap returned to the cylinder. In Fig. 2., Eq. (1b) is plotted at two temperatures as a function of the number of molding cycles, n, using the experimental $\bar{\eta}sp$ (t) values from Fig. 1. Also in Fig. 2 we have plotted the experimental $\bar{\eta}$ exp (n) values from Table I. The agreement between experiment and theory is good. The small fluctuation in the $\bar{\eta}$ exp (n) is probably due to small differences in the density of packing of the cylinder charge and the cylinder temperature in the course of the molding. In Part I we defined the mean number of heatings of an aliquot of the cylinder charge just before the n + 1 st heating, H(n). This quantity already attains its limiting value, $H(\infty) = 1.5$, after about four heatings (a = 0.18), so that it is not surprising that the asymptotic extent of degradation appears to be reached after about 3 or 4 molding cycles.

The substantial agreement between the theory, using data obtained from continuous heating experiments, and the molding experiments as shown in Fig. 2 indicates that probably the predominant type of degradation of polystyrene at these cylinder temperatures and pressure is thermal degradation rather than "frictional" degradation. The molded material appears little changed in molecular structure from the "virgin" material as is indicated by the constancy of the Huggins k' value determined from the slopes of the viscosity—concentration values, (k' molded = 0.42, k' virgin = 0.43).

The kinetics of the polystyrene degradation as seen from the viscosity versus time curves, Fig. 1, are complex. After the transient response lasting about two minutes, the kinetics appear to follow a zero order law with respect to viscosity.

$$-\partial\bar{\eta}sp / \partial t = k_0 \qquad (2)$$

where k_0 for the polystyrene at 460° F. has the value 0.047 min. $^{-1}$ and at 560°F. the value of 0.055 min. $^{-1}$. Assuming that k_0 obeys an Arrhenius relation we find an apparent activation energy of 1.5 kcal., this low value being not inconsistent with the apparent kinetic order.

As is well-known[3] the ultimate strength of high polymers depends not only on the thermodynamic and molecular properties such as the chemical structure, molecular weight and molecular weight distribution of the sample studied but also on the orientation, crystallinity, presence of impurities and flaws as well as time effects. In view of this complexity, ultimate strength measurements, especially those involving rupture such as the

(please turn to page 42)

[3] *T. Alfrey, Mechanical Behavior of High Polymers, Interscience, New York, 1948.*

Dry Blending of Vinyl Compounds

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THE PROCESS OF DRY BLENDING, as the term indicates, is the blending of all the ingredients of the formulation into a free-flowing, dry powder of a sandy character. No further compounding is required prior to extruding. The essential difference between the dry blending process and the fluxing process is that the former must take place without any confinement in the form of pressure on the mix during the heat cycle. No attempt will be made, at this time, to justify the advantages of dry blending as they are quite obvious. However, it should be pointed out that there is room in the industry at the present time for both the dry blending and the fluxing process. This is particularly true for certain formulations which do not lend themselves to dry blending.

The technique of extruding these dry blend compounds depends primarily on two types of processing equipment, namely the mixer or blender together with the extruder. There has been considerable controversy concerning these two phases, particularly the latter. It is quite difficult to discuss the mixing equipment without taking into account in what manner the compound will be processed in the final operation. There are some who are of the opinion that if an extruder could be designed with better compounding or fusing action than the present type, then the actual mixing of dry blend stocks would be considerably simplified.

Furthermore, in considering the type of extruding equipment which is now being used there are at least two additional items which must be taken into account. The first is the quality and production requirements of the product to be produced. The second is the type of formulation required to produce that product. In every dry blend operation all of these factors are dependent one on the other and none of them may be changed without effecting the overall set-up.

In many instances there have been numerous attempts to overcome certain objections to either the mixing or extruding process by altering within limits the formulations used. Everyone is quite familiar with the dry blending claims made by the various resin suppliers for their particular grade of resin. The question of how far the development of superior dry blending resins can be carried may be in the same category as the ultimate design of an extruder-compounder. The effect of other compounding ingredients such as plasticizers, stabilizers, fillers, etc. also must be considered in formulating for proper dry blend processing. From time to time there are reports that various processors have obtained better extruding results by using certain plasticizers in various amounts.

Therefore, in discussing the pros and cons of the numerous types of mixing or blending equipment, we must bear in mind the extent to which the success of the operation is dependent on factors mentioned above.

As pointed out above, the finished dry blend should be a dry free-flowing powder in which all the ingredients are dispersed as homogeneously as possible. The purpose of the mixing equipment is to accomplish this uniform blending, particularly from the standpoint of plasticizer distribution which is dependent directly upon the absorption at a pre-determined temperature of the plasticizer by the resin. It is true that there have been instances where mixes of non-uniform plasticizer distribution have been deliberately produced, because it was thought that such mixes gave better extruding properties. These mixes can be considered being in two phases. However, these phases are also blended in a homogeneous manner.

There should be no balling or lumping of any of the ingredients. This is usually taken care of by either screening the dry ingredients, particularly the fillers and stabilizers prior to mixing or treating the finished mix in a like manner. In some cases both methods are being used.

There should be no balling or lumping of any of the blending on a commercial scale. All of these have certain advantages and limitations. The size of the operation, together with the type, will govern the ultimate selection of any equipment. The fundamental principle of the operation, however, should not change irrespective of the kind of equipment used.

Quite often the question is asked why it is so difficult to select a particular type of equipment as being suited for dry blending operations. To those who are not directly connected with the industry this seems to be a fair question which might be easily answered. With all the ramifications previously mentioned, this becomes rather a problem as evidenced by the numerous types already in use throughout the industry.

Let us discuss very briefly some these types of equipment. The first is commonly known as the ribbon blender and has appeal because of the fact that it is low in cost, is easily maintained and is fairly flexible in mixing procedure. It is also obtainable in a variety of sizes. Some of the objections to this mixer have been the difficulty of cleaning and the tendency for the dry blend to adhere to sides of the blender during the mixing cycle. The finished mix is usually either screened or processed through an attrition mill or some similar device. This is usually true, however, as pointed out previously for other types of mixers.

The next piece of equipment is the muller type of mixer which has many advantages such as short and controlled cycles, together with a rather intensive mixing action. It is not readily adapted to mixing variations in compounding formulations.

Internal mixers, sometimes classified as semi-intensive, have made their way into the industry. They have the advantage of being easily cleaned, being quite flexible both in mixing technique and formulation variations together with good mixing action. The initial cost of this equipment is high when compared to that of a ribbon blender.

Steamed jacketed conical blenders, with and without vacuum, are also being used. They offer some of the advantages of the ribbon blender, but at the same time are not as flexible and are somewhat lacking in mixing action.

Dough type mixers with steam heated jackets may be considered in the same category as ribbon blenders. They too are fairly flexible in mixing technique. As a matter of fact, in the early days of dry blending cement mixers, which were heated by gas burners, were used for experimental purposes. It might well be that at this moment there are in use modifications of the above type of equip-

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AROUND THE WORLD

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ARGENTINA

PLASTICOS

Vol. 2, No. 6, Oct.-Dec. 1953

Abstracter: John B. Ballard

CHAMBER AND COOPERATIVE—Editorial

A discussion of the newly-formed Supply Cooperative of the Plastics Industry. Its principal function is to handle domestic and foreign purchases of raw materials, machinery, tools, and supplies for its members. It may also supply credit, furnish technical advice, or train employees. It will cooperate with the Argentine Chamber of the Plastics Industry, which publishes the magazine "Plastics." The organization meeting, attended by over a hundred members of the industry, is reported (date not given) and the officers listed.

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AUSTRIA

OESTERREICHE PLASTIC RUNDSCHAU

January-February 1954

Abstracter: Herbert Meyer

OPENING OF THE AUSTRIAN PLASTICS INSTITUTE: pp 6-8

The opening of the Austrian Plastics Institute took place December 11, 1953. It will be self-supporting through membership fees and contributions by the plastics industry and through income derived from its activity in the field of economic and technical research, industry product evaluation and testing. The principal tasks of the institute were defined in the opening address given by Director Stoegerer as follows:

1. Current study and evaluation of domestic and foreign professional literature and establishment of a library.
2. Current study and evaluation of domestic and foreign patent literature.
3. Information service on properties and application of plastics.
4. Publishing of information to promote the use of plastics and plastic fabricates, and to further their proper employment.
5. Professional guidance and education for the oncoming generation.
6. Collaboration with foreign institutes of related interests.
7. Engaging in projects concerning the investigation of methods for producing and processing plastic materials and fabricates.
8. Quality control, testing and evaluation of plastic materials and fabricates of domestic and foreign origin.
9. Issuance of certificates of approval for plastic fabricates.
10. Collaboration in the establishing of standards.
11. Research in the field of plastics.

SILICONES: pp 8-9

A general article describing various commercial uses for silicones states that such compounds have only recently been imported to Austria. The applications suggested are:

1. Formulation of lacquers resistant to heat, light, water, chemicals and exhibiting good electrical properties.
2. Cleaning and polishing compounds for metal, wood and glass.
3. Protective coatings and mold release agents.
4. Special adhesives.
5. Anti-Foaming agents.
6. Sizing aids for textiles and fibers. Impregnating compounds for paper, leather and wood to increase water resistance.
7. Elastomeric materials.

CONTINUOUS COATING OF CABLES WITH NYLON BY EXTRUSION: By Dipl. Ing Kohlwy pp 10-14

The article, after briefly discussing the properties of Nylon resin, describes in detail the various steps of fabricating Nylon covered cables by extrusion. It includes valuable pointers concerning the design of the extruder equipment and the operation itself. Pre-heating, melting, conveying, homogenizing of the fluid material and extrusion are well covered. Special attention is given to the important factors of correct polymer orientation and exclusion of moisture. Flow sheets illustrate the processing arrangement for small and large size cables.

HIGH FREQUENCY AND INDUCTION HEAT SEALING OF THERMOPLASTICS, pp 18-19

Both principles are well described with reference particularly to the completely automatic high-frequency heat sealing press manufactured by Lorentz. It is pointed out that these methods complement each other since the high-frequency heat sealing principle cannot be employed with plastic foils below a minimum thickness while the induction heat sealing process fails with material above a certain maximum thickness.

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FRANCE

INDUSTRIE DES PLASTIQUES MODERNES

Vol. 6, No. 6, June, 1954

Abstracter: Hans Mayer

PLASTICS IN THE SERVICE OF AGRICULTURE. RAPID INSTALLATION OF POLYETHYLENE IRRIGATION SYSTEM

The installation of the system of polyethylene piping in trenches through vineyards described does not serve to provide water but to supply the chemical solutions which have to be applied to the vines immediately following rainfall. The installation of the piping, the preparation of the grounds, the machinery employed, etc. are described in detail and a comparison of the expense is made, showing that the higher price of the polyethylene tubing itself is more than compensated for by savings in the installation and reductions in the cost of replacements.

THE "NERVE" OF PLASTIC MATERIALS: R. E. Asche

The author proposes a new standard of comparison for plastic materials the "nerve" which would represent a unit of measurement for the elastic rebound of a given quantity of material. It is explained why such comparison is important and how comparative tests could be conducted.

DECOMPOSITION OF TEFLON BY GAMMA RAYS: S. W. Ryan

The test conducted at the Oak Ridge National Laboratories are discussed.

INDUSTRIE DES PLASTIQUES MODERNE

Vol. 6, No. 7, July, 1954

FRENCH PRODUCTION OF PLASTICS DURING 1953

The production of plastic materials in France has increased seven times over the production of 1938 and has doubled compared to 1939. The use per person is still very small with appr. 3 lbs. per annum and even on this basis appr. five times as much material had to be imported as was left for exports to foreign countries. Of the total consumed the vinyls account for appr. 28%, polystyrene for appr. 15%, phenolic materials for appr. 8% while the other plastic materials account for the balance. Plans which are in the state of execution now, promise to make France self supporting as far as vinyls and polystyrenes are concerned.

MELAMINE MOLDING POWDERS: J. Bost

Production of the material, the molding techniques to be used in compression and transfer molding, the physical properties of the molded articles are described. This material is not produced in France and sources of supply are enumerated, amongst the USA sources Plaskon is not mentioned while the Catalin Corp. is listed erroneously.

CORRUGATED TRANSLUCENT FIBERGLASS PANELS

It is stated that this product is being produced in France on a commercial basis now. Its uses as roofing and partitioning sections are described. The material is claimed to have a 80 to 85% light transmission, the weight of the panels is appr. 5 lbs. per sq. meter.

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GERMANY

KUNSTSTOFFE

Vol. 44, No. 5, May, 1954

Abstracter: Anne Schwend

THERMOSETTING SILICONES FOR THE ELECTRICAL INDUSTRY, Paul Nowak and Erich Rickling

Increased thermal demands in the electrical industry have led to the development and preference-use of high molecular organo-silicone compounds in the form of highly and feebly interlaced silicones. A multitude of production possibilities secured silicone impregnating lacquers and pastes for glass-silk coated copper wires f.i., glass-, asbestos- or mica-filled silicones for slot wedges, slot linings, intermediate layers, etc., and silicone caoutchouc for glass-silk insulating materials. These materials make it possible for designers to reduce the dimensions of electrical equipment without reducing the capacity. Silicone-insulated equipment copes with high thermal surcharges and is of particular interest for the mining industry due to the special protection against explosions it guarantees.

The results of tests with two types of silicone compounds having a methyl-phenyl ratio of 1.0 : 0.65 and a lower percentage of phenyl groups, differentiated by their varying content of tri-functional siloxane units, are published. Flexural strength, shrinkage resistance, aging under heat influence, effect of setting accelerators, and the thermal influence on the elasticity of silicones were investigated and the conclusions laid down in charts. Similar investigations were conducted with feebly interlaced elastomeric methyl silicones with a ratio of methyl to silicon of 2:1, mixed with active or inactive fillers up to 30 or 60% respectively. Such silicone caoutchouc compounds may be well used for constant exposure to heat of up to 356°F. The AEG Co. of Germany has introduced a mixture of silicone caoutchouc compounds with glass tissues which does not only excel thru high heat resistance but also resistance against humidity which makes this material particularly fit for electrical purposes.

CHEMISTRY OF PHENOLIC RESINS

A brief review of addresses held during the colloquium of the organo-chemical institute of the Mainz University: H. Meis: Synthesis of phenolics according to the Cumol procedure; M. Grossmann: Dehalogenation of chloro-phenol alcohols; K. Hultzsch: The significance of model reactions for the chemistry of phenolic resins; E. Ziegler: Cyclic phenol formaldehyde condensates; H. Kammerer: Polymer-uniform and polymer-isomeric phenol-formaldehyde polycondensates; J. deJonge: The reaction of phenols and formaldehydes in dilute solutions; H. F. Mueller: The relationship between synthesis and technical attitude of phenolic resins.

DEVICE FOR MEASURING THE ADHESION OF PLASTIC FILMS, Wilfried Voigt

Contrary to the hitherto used system of a dynamo-meter balance for determining the adhesive strength of bonded films, there is a description of sort of a pneumatic power gauge, the piston of which plunges into oil at the lower end, thus avoiding oscillations during the measuring process. The piston-weight is equalized by a small counter-weight. Power differences as low as 1 gram are easily being registered by a pressure gauge the water content of which is dyed with fluorescein.

PROCESSING AND APPLICATION OF SILICONE CAOUTCHOUC, Manfred Wick and Wolf Dietz

Part 2 (for part 1 see April abstracts) of this work on silicone caoutchouc gives information on practical processing methods including vulcanization (hot air tunnels, infrared radiation) and tempering, treatment of silicone modified pastes, foamed materials and strips as well as their electro-technical and mechanical application, citing the properties then exhibited.

INJECTION MOLDING OF POLYSTYRENE, Herbert Mertz

The interrelation of injection molding compounds, molding temperatures, mold temperatures, injection pressures and production cycles is investigated on the basis of two articles by C. E. Beyer R. B. Dahl (Modern Plastics, March 1953) and R. S. Spencer G. D. Gilmore (Journal of Applied Physics, 1949).

STYROPOR—a novel foamed plastic (Part II), F. Stastny

Cutting, sawing, milling, slicing of Styropor granulated material, bonding, laminating and coating with a more durable outer skin, as well as flaking, applying non-inflammable coatings, immersing in paraffin melts in order to obtain a densely closed surface, dyeing and welding processes are discussed. The properties produced by the various methods are investigated: structural strength, shaking strength, resistance to water absorption, low water vapor permeability, excellent dielectric insulating capacity, chemical resistance against water, weak and strong acids as well as alkalies growth and bacteria. The use of Styropor for floatable light-weight bodies, thermal insulating purposes especially where low temperatures are concerned, for the building industry and light-weight individual parts is ventilated.

DESIGN OF INJECTION MOLDS FOR FLAT AND DEEP-DRAWN PARTS, Hans Gastrow

Something about the technique of designing molds without ejectors for flat parts and molds with ejector plates or pins for deep-drawn parts.

KUNSTSTOFFE

Vol. 44, No. 5, June, 1954

CONTINUOUS FEEDING OF SHEETING CALENDERS, K. Stoeckhert

The high standard reached by modern calenders make it necessary to pay more attention to the equipment and machinery preparing the feed. The possibility to reduce the manpower needed for handling continuously feeding machinery, reduce the amount of energy required per kilo of material put through, plus the advantage of improving the quality of the end product make it advisable to give considerable thought to this problem.

A survey on the tasks and requirements in calendering is followed by

a description of presently existing machinery for continuous feeding: diversified types of mixing roll mills, Banbury mixers combined with roll mills, mostly arranged underneath the Banbury mixer and serving rather as drawing rolls than mixing rolls in order to preform the material into rolling hides; insertion of extruders between roll mill and calender; description of a new "gelatinizer-belt-heater" which serves to increase the temperature of the rolling hide but neither mixes nor reduces the gelatinized granules, consisting mainly of a steel belt running in an infra-red tunnel. At one end a paste of PVC plasticizer plus all required additions is spread on the belt while at the other end the gelatinized sheet is fed immediately between the first two rolls; the thermal stress on the material is lower than in other machinery since the oxidizing effect of air during the kneading action is eliminated.

Attempts to let single and multple screw extruders do all the preparatory work are enlarged upon. The extruded material is cut in half near the orifice and fed by conveyors between the outer edges of the rolls, the conveyors moving slowly towards the center of the rolls and back to the edges, thus guaranteeing uniform feeding. The "kneading extruder" by Paul Leistritz, Nuremberg, the double-screw-extruder of Harburger Eisen - und Bronzewerke, Hamburg, the "mixtruder" by Joseph Eck & Soehne, Dusseldorf, the "co-kneader" of Buss A.G., Switzerland, and the "Plastificator" of Werner & Pfleiderer-Wacker-Chemie, Munich, are reviewed for their feeding capacities and other features. Reference is also made to a new machine by Carlo Pasquetti, Varese-Masnago, Italy, resembling a triple gear pump.

PLASTICS AND PLASTICS PROCESSING AT THE HANOVER TECHNICAL FAIR 1954—Dr. J. Hausen

The German plastics industry showed some remarkable developments at the Hanover Fair:

BASIC AND SEMI-FINISHED MATERIALS

Farbenfabriken Bayer exhibited casting resins and low pressure non-saturated polyester resins, a boat of 5 m in length and 1.25 m in width demonstrating the use of glass fibre reinforced polyester resins. Further, mold lubricating agents: silicone oil emulsion "Bayer 100" and silicone oil "Bayer 100" which may even be added directly to the plastic material. Silicone caoutchouc is now being marketed under the trade-name "Silopren".

Agfa AG. showed a new type of magnetic tape using polyvinyl chloride as base instead of acetyl cellulose.

Badische Aniline & Sodafabriken demonstrated the use of high molecular polyethylene "Lupolen H" and various kinds of polystyrene in practice. Vacuum-forming of impact-resistent polystyrene "EB", pre-formed into sheets and ribbons on extruders seems to be prospective. Glass-fibre reinforced dyed casting resins were introduced with a jolly-boat. PVC co - polymerizers for plasticizer - free transparent sheets and plates and "PVC MP Type T" for the production of records were shown.

Farbwerke Hoechst now offers polytrifluoromonochloroethylene as transparent bubble-free granules.

Wacker-Chemie GmbH released information on their experience with the lifetime and capacity of silicone insulated electric motors (20 times as durable as other executions and 50% higher capacity).

Rohm & Haas introduced "Plexidur T", a new material of high strength and toughness of yellowish color.

Dynamit AG. had put on a big show of applied plastics in the building trade and interior decoration. They also exhibited a new plastic material on the basis of Vulcollan for wear-resistant linings and rubber-elastic parts of high non-abrasiveness. Type "9900" has been added to the assortment of melamine resins, a pure melamine which is supplied in various colors and with different fillers. "Trolitul" impact-resistant (styrol + butadiene) was offered for injection molding.

INJECTION MOLDING MACHINES

Eckert & Ziegler exhibited a new electro - hydraulic injection molding machine type "EHS 30" for piece weights up to 20 grams. Standard type "EH 160+" is now furnished with a built-in-self-contained oil drive.

Gebr. Battenfeld offers 15 different types of injection molding machines, four of which work in vertical direction. All machines are now equipped on the injection side with a pneumatic cushion which facilitates setting and reading off the injection pressure. Automatic ejection on all fast cycling injection molding machines was improved and safety precautions built in to guarantee that as long as plastic particles as small as 0.05 mm in thickness remain in the mold, the machine will not continue in performance. Further, improved pre-plasticizing and a newly developed cylinder which renders changes in color or material easier, were of interest.

Anderwerk Gebr. Goller showed two new oil-hydraulic automatic injection molding machines type SE 50/75 with up to 720 shots per hour and a nominal capacity of 50 cu. cm, maximum capacity 75 cu. cm, and type SF 600 for up to 700 cu. cm. in acetate with infinitely variable speed control and a plasticizing cylinder which is regulated in four places and photo-electrically controlled in three places.

The machines of Tuckmantel Hydraulikbau GmbH govern the mold closing pressure fully mechanically, while the injection pressure is working fully hydraulically. Their machines feature a new type of injection cylinder without spreader.

EXTRUDERS AND OTHER PLASTICS MACHINERY

Reifenhaeuser Troisdorf showed a newly developed extruder for polytrifluorochloroetheylene with a specially formed extrusion head. Barrel and screw are of highly acid-resistant steel.

CMA Chemiemachinen und—Anlagen GmbH introduced a novel type of extruder in which the back-pressure of material in the barrel may be influenced variably, thus completely melting the material without using built-in hold-backs and obtaining a homogeneous flow of material. Also a vacuum-forming machine was exhibited.

Maschinenfabrik Paul Troester's extruder had a broadly slit orifice for thin sheets and paper-coating. The width of the orifice is adjusted by a number of differential screws arranged along the length of the nozzle.

Heinrich Koch introduced a universal extruder working with plastic powdered material and skipping the granulation process.

Werner & Pfleiderer showed a dispersion and plastic kneader of unusually high kneading and shearing capacity. A double-bladed universal mixer and kneader of special design for the pre-gelatinization of PVC plasticizer compounds, with double barrel for heating and direct injection of the plasticizer was of particular interest.

An auxiliary device making continuous operation of agitators possible, shown by Henschel Flugmotorenbau, may find much approval since it permits working of highly viscous plastics of paste-like character.

Dr. A. Stankiewicz improved sound-insulating materials, particularly a sound-deadening plaster which was well received in practice.

Zwick & Co. had a newly developed gauge for flow tests as well as one for testing foamed plastics.

PLASTICS IN THE BUILDING INDUSTRY, Irene Saechtling

The institute for applied plastics of the Technical High School at Aachen arranged for an extra-curricular meeting which brought many suggestions and approaches for the use of plastics in architecture, building technique and interior decorating. This colloquy found a large and interested audience.

MIGRATION OF PLASTICIZERS IN PVC, Lisa Roessig

Reprint of an address held at the

Swedish Plastics Congress in Stockholm, November 1953, constituting an introduction into testing methods as applied in the laboratories of Farbenfabriken Bayer, Uerdingen plant, which show that the migration of plasticizers can only be determined with the help of methods coordinating both kinds of plastics: that releasing the plasticizer and that absorbing the plasticizer.

CONDITIONS OF SUPPLY, PROCESSING AND APPLICATION OF RIGID PVC

Former DIN Standard 8061 was reviewed and changed to answer present-day requirements. The text of the new draft standard is reprinted.

DESIGN OF INJECTION MOLDS, H. Gastrow, Berlin

The technique of designing injection molds for parts to be ejected by stripper plates is discussed.

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GREAT BRITAIN

BRITISH PLASTICS

Vol. 27, No. 4, April, 1954

Abstracter: E. A. J. Mol

SOME PROBLEMS IN INJECTION MOLDING IN CELLULOSE ACETATE, H. J. Lovell, pp. 138-139

The defects discussed comprise: Discoloration, sinks and voids, silver surface, dull finish, shrinkage after molding, flow lines, burn marks, brittleness or surface laminations, bubbles. The causes of these defects are analysed and remedies suggested in terms of molding conditions (mold temperature, cycle time, pressure, venting, gate location and gate form, moisture control.)

TEMPERATURE CONTROL IN INJECTION MOLDING, L. Griffiths, pp. 134-136

Temperature variations in heating cylinders often are the cause of quality variations. To avoid excessive 'hunting' of the surface temperature of the inner cylinder wall, the thermocouples, controlling the heater bands, are not placed in the cylinder wall close to that inner surface but on the contrary, close to the heater bands. The beneficial effects of this method on the temperature fluctuations in the cylinder wall are convincingly demonstrated by the given temperature v. time characteristics.

ALKYD MOLDING MATERIALS, C. A. Redfarn, pp. 131-133

To be thermosetting in character, the alkyds, used for molding, must possess reactive ethenoid linkages, introduced for instance, by partially esterifying with unsaturated acids like maleic or fumaric acid or with an unsaturated alcohol like allyl alcohol.

As no volatiles are given off in the curing operation, only low molding pressures are required, curing is very fast (2 - 3 x the speed of phenolics) curing temperatures 300 - 320°F. Storage life is limited and moisture pick-up during storage must be prevented.

Physical properties of alkyds are better than those of phenolics, electrical properties are about the same, although alkyds seem to be better under humid conditions. The alkyds are much more expensive, compensation for this can be found if advantage is taken of the faster curing of alkyds.

PLASTICS AT THE IDEAL HOME, pp. 116-121.

Impressions of the Daily Mail Ideal Home Exhibition. Plastics as components of refrigerators, gas and electric cookers, vacuum cleaners and electric polishers, and washing machines. Much prominence was given to Nylon. Polyethylene seems to be rapidly becoming a maid of all work; the strength, durability, warm touch and hygienic qualities fit it for a surprising variety of applications and the public has been quick to take them up, from baby baths to squeeze bottles and from buckets to infants' pots.

BRITISH PLASTICS

Vol. 27, No. 5, May, 1954

RECENT DEVELOPMENTS IN GLASS-POLYESTER BOAT PRODUCTION: Anon. pp. 154-157

This is a fairly detailed description of how 9, 12 and even 45 ft. seagoing launches are built of random-glass-mat polyester low pressure laminates. Gunwales, buoyancy tanks and even center board box are integrated with the hull. Interesting is the use of light alloy sections in formers to support the laminate as stiffeners or ribs. To save finishing time the outer surface is prepared separately by brushing the inner surface of the mold with a filled and pigmented gel coat after applying a releasing agent and prior to placing the 2 oz. random mats in position.

The 45 ft. hull weighs about 3750 lbs. and costs $5700 to make including the costs of the molds. This closely approximates the cost of a wooden hull, the big advantage is the considerably shorter building time.

INJECTION MOLDING OF VINYL NOZZLES: Anon. pp 158-160

Vacuum cleaner nozzles in flexible vinyl are becoming increasingly popular. The molds used in producing nozzles are described. In one case a tool consists of 8 separate components to cope with the intricate design, including several undercuts. To obtain a high gloss finish, the correct position of the gate turned out to be very important, preheating the molding powder also helped. As can be expected in vinylchloride-copolymers, the tendency to decompose is a major problem. Temperatures have to be closely watched and the material must be kept moving all the time.

SPRAYED PLASTICS COATINGS: R. Dickinson, pp. 171-175

Flame spraying methods are as yet confined to thermoplastics. They are based on the older experiences with solution spraying but have the following advantages: no loss of solvent, no drying time, insoluble polymers can be handled, thicker coatings (10 mils) can easily be applied in one treatment. Surfaces should be thoroughly clean, sand blasted or degreased. Suction- or induction fed pistols and pressure fed types are both in use. Practically any combustible gas can be used for heating, propane is readily available in cylinders and is one of the cheapest and most efficient gases. The average consumption of propane and oxygen when spraying is 22.0 and 77.5 cu.ft. per hour respectively, compressed air consumption 400 cu.ft. h. Under those conditions, polyethylene for example can be sprayed at a rate of 5 lbs h covering 80 sq. ft. h with a 10 mil. coating. Besides polyethylene, nylon, thiokol, shellac, epoxy-resins and low viscosity acrylics have also been flame sprayed with considerable success.

STABILIZERS FOR VINYL POLYMERS: H. Verity Smith, pp. 176-179

The heat history of vinyl products may comprise mixing and fusing (in heated Banburys or on heated mills) and forming by injection molding, extrusion or calendering. This requires some form of heat stabilization to prevent excessive HCl-formation. Stabilizers are very difficult to evaluate as their effect often greatly depends on the other components in the system, polyvinylchloride, plasticizers, pigments, fillers, lubricants, other stabilizers. Several classes of stabilizers are available, in this article, part I of a series, only the metallic soaps are considered. Mainly on economical grounds, the following metals are in practical use: Li, Na, Mg, Ca, Sr, Ba, Zn, Cd, Sn, Pb. The acids used in the soaps include: stearic acid, ricinoleic acid, naphtenic acid, lauric acid. Many stabilizers currently on the market are discussed, both their proprietary brands and their compositions are given. It is interesting to note that the oldest and simplest vinyl stabilizer, basic lead carbonate, still is the most important of all in terms of tonnage.

BRITISH PLASTICS

Vol. 27, No. 6, June, 1954

AIRCRAFT JIGS IN GLASS-REINFORCED POLYESTER: Anon. pp 206-210

Describes production and application of form blocks, beating blocks,

BRITISH PLASTICS

(Vol. 27, No. 6 continued)

drill jigs for Aircraft parts, drill and trim jigs for spherical pressure dome, drill jig for double skinned acrylic canopy of a particularly difficult winding contour and a large drill jig for drilling rivet holes in the leading-edge panels of an aircraft wing.

GLASS POLYESTER FOR SCOOTER AND INVALID CAR: Anon. p 211

Description of paneling for lightweight motorized scooter made of chopped strand mat and Marco 189 polyester and a carriage body for a motorized 3-wheeled invalid carriage.

STABILIZERS FOR VINYL POLMERS: H. Verity Smith, pp 213-217

This is the second in a series of three articles by H. Verity Smith on the subject. The first one dealt with metallic soaps, this one concerns metallic compounds other than soaps. Described and discussed in detail are: Phosphates and Phosphites, Persalts, Silicates, Sulphates, Oxides, Salicylates, Phthalates, Alcoholates and Organo-metallic compounds ilke organotincarboxylic acid salts, hydrocarbon tin alcoholates and polymeric organotins. In most cases the proprietary brand names are also mentioned which is a great help to buyers.

NEW 2½-INCH EXTRUDER: Anon. pp 222-223

This is a description of the new 2½ in. Peco "Universal" Extruder. Everything has been done to make this machine truly universal. The barrel length is adjustable (1 D can be made 11 1 and 16 1), interchangeable screws of varying pitch, length and design are available for the most efficient handling of different plastics, they can be cooled if wanted. The barrel temperatures are automatically controlled in five independent zones up to 235 C, the barrel can also be cooled. The 15 hp. drive gives continuously variable screw speeds between 12 and 100 rpm, the thrust race is very robust and has a capacity of 34300 lbs. at 100 rpm. Sketches of the machine and a number of screws are added.

LIQUID HEAT CARRIERS: Leo Walter, pp 218-220

The advantages of liquid heating of extruders, injection molding machines and calenders (uniform heating and rapid cooling, closely controlled surface temperatures) are discussed and the various liquids available are listed, together with the maximum temp. they can be used at. The necessary instrumentation is also discussed.

Set Sail For
ATLANTIC CITY
See Page 15

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PLASTICS

April, 1954

Abstracter: Alfred T. Rexer

POLYTHENE FILM FOR HORTICULTURE: by E. R. Webber, pp 108 to 109

A short article with illustrations explains the use of polyethylene film in the air-layering of woody plants to induce rooting. In addition, the very low permeability of moisture and relatively high permeability of gases which are properties of this material enable its use for other methods of rooting cuttings, germinating seeds, and various other horticultural uses.

PLASTICS IN THE SERVICE OF MAN: pp 112 thru 115

A pictorial review of high-quality plastic units molded or otherwise fabricated in Great Britain covers the field of tools and engineering components.

NEW APPLICATIONS OF LAMINATED P. V. C.: by F. F. Jaray, pp 130 thru 132

This article discusses the limitations of rigid p.v.c. and the experiments started by the author and BX Plastics, Ltd. to combine a rigid p.v.c. sheet with a plasticized one by means of fusion welding in order to improve the impact strength. The author prophecies that in the near future, fabricated articles will more and more tend to be made from comparatively thin laminated material, with suitable ribs or stiffeners. The use of unlaminated ordinary rigid p.v.c. will probably decrease considerably.

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HOLLAND

CHEMISCH WEEKBLAD

No. 2523, April 24, 1954

Abstracter: W. P. ter Horst

FLUIDITY MEASUREMENTS OF CELLULOSE SOLUTIONS BY THE NITRATE METHOD:

F. H. Robaard, pp 297-307

The nitrate method consists in nitrating cellulose without breaking up the chains and measuring the fluidity of a solution of the cellulose nitrate in an organic solvent. This method was compared with the cuoxam- and the cupri-ethylenediamine methods. It offers some advantages but can be adversely affected by variation in the nitrogen content of the nitrated samples. In general there is no reason to prefer the nitrate method.

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PLASTICA

Vol. 7, No. 4, April, 1954

Abstracter: W. P. ter Horst

APPLICATION AND POSSIBILITIES OF POLYESTER RESIN: H. A. K. Eden

In this article the author discusses the applications of unsaturated polyester resins from a technical-economical point of view. Casting resins, alkyd moulding compounds and polyesterglassfiber materials are successively dealt with and much attention is paid to the necessary investments.

REINFORCED PLASTICS: W. H. Brinkman

Reinforced phenolic resins are discussed. The reinforcement exists of asbestos or glassfibers. The asbestos-phenolic materials, an English development, are mainly used in the construction of large objects — radio aerials, glider wings—where stiffness of the material is an important factor. The glassfiber-phenolic materials are arousing much interest because of their excellent heat resistance, which in some respects is even better than with the light metal alloys.

PLASTICA

Vol. 7, No. 5, May, 1954

POLYSTYRENE SCINTILLATORS: W. Prins and H. de Waard

Properties of scintillators for registration of radio-active radiation are treated. The advantage of the use of solid solutions in polystyrene is discussed and a method is described for preparing very good scintillators by injection moldings.

PLASTICA

Vol. 7, No. 6, June, 1954

PRINTING OF POLYVINYL-CHLORIDE FILM: K. Zaabe

In this article the two methods generally used in printing P. V. C. film and sheeting, e. g. gravure-printing and silk screening are discussed. The equipment used is described and some notes on the finishing and the outlook of printed P. V. C. are given.

RESISTANCE TESTING OF PLASTICS: A. Burgers

Difference is made between volume resistance and surface resistance. The influence of several factors upon the resistance of plastics is discussed. Some methods of determining very high resistances are described.

PLASTICA

Vol. 7, No. 7, July, 1954

NYLON GEARS AND BEARINGS J. F. Kohlwey

The principal properties of nylon with regard to its use in gears and bearings, are the high tensile strength

the high modulus of elasticity and the excellent abrasion resistance. Other properties which are of importance to this particular field are also discussed briefly. After some remarks on the machining of nylon detailed instructions to the design and use of nylon gears and bearings are given.

EPOXY RESINS: **O. E. van Lohuizen**

A survey is given of the chemical structure, preparation and hardening mechanism of epoxy resins. A number of applications is mentioned.

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UNITED STATES

ELECTRICAL MANUFACTURING

Vol. 53, No. 5, May, 1954

Abstracter: **Gerald Eisner**

DIELECTRIS STRENGTH OF SOLID INSULATION, **J. J. Chapman and L. J. Frisco,** page 136

The authors who work at the Dielectric Laboratory, Institution for Cooperative Research of the John Hopkins University, report on the dielectric strength of twenty-two materials as a function of frequency of the applied electrical stress. Phenolics, Polytetrafluorethylene, Polyethylene, Polystyrene and Melamines were compared with results tabulated and charted.

In setting up the experiment, the authors were forced to go to considerable lengths to develop techniques of attaching metallic hardware to specimens to avoid corona. These methods might be of value in solving similar problems in electrical apparatus design. The experiments showed a need for careful choice of insulation to avoid unnecessarily expensive materials as well as inadequate materials.

ELECTRICAL MANUFACTURING

Vol. 54, No. 1, July, 1954

DETERIORATING INFLUENCES ON DIELECTRIC MATERIALS: **L. J. Berberich,** Page 103

Mr. Berberich of Westinghouse Electric compares the effects of oxygen and temperature on aging of dielectrics. The dropping of tensile strength and the amount of gas evolution was the test method of determining the deterioration. A very interesting discussion of the erosive effects of corona discharges on the plastic dielectrics is given. This article was reprinted from Prof. A. R. von Hippel's book, "Dielectrics Materials and Their Applications" to be published soon by the Technology Press and John Wiley & Sons, Inc.

Dry Blending Vinyl . . .

(continued from page 33)

ment which in most cases have been adapted to a particular process.

From the above discussion several fundamental concepts of the requirements of a mixer may be determined. These concepts are irrespective of initial and maintenance costs. To begin with, the mixer should be able to be easily cleaned particularly from the standpoint of self cleaning after the batch has been dumped. It should have good and flexible temperature control. The mixing action should be positive with no dead spots so as to be able to achieve both short cycles and variations in formulations. It is also desirable not to have too close a limit on the weight of the batch that might be mixed. In discussing the mixing action, the term intensive has been used. This term usually is connected with mixers such as the Banbury where the compound is fluxed. Therefore, some distinction must be made when discussing dry blending.

The point that should be made clear on mixing cycles is that the efficiency of a particular mixer depends on its mixing action which will in turn automatically control the cycle for that particular formulation being compounded.

However, in the final analysis, the overall picture must be considered in the selection of any mixing equipment. The writer has tried to bring out some points which might aid in a better understanding of the problem.

ELECTRICAL MANUFACTURING

Vol. 54, No. 2, August, 1954

BUSINESS MACHINE HOUSINGS FROM GLASS-REINFORCED POLYESTERS: **Byron W. Nelson** Page 94

Mr. Nelson of The National Cash Register Company describes in this article the culmination of a 6 year study of glass-reinforced polyesters. His company changed from aluminum castings to the polyester with a resultant 30% decrease in cost and 40% saving in weight on one of their standard accounting machines. Although they gained these advantages as well as a noise reduction, the author cautions other manufacturers of similar housings to make complete studies of tooling, methods and materials before choosing between metal and reinforced parts.

Set Sail For
Atlantic City

N. W. Pennsylvania Section News

Paul C. Roche

No initial fall news report should be considered without happy mention of an SPE Section summer outing. This season rates customary compliment in this regard, with special honors to Lloyd Moore, Bill Phillips, Don Leett and other busy committee members. With at least 125 attending the event was typically successful not only from the standpoint of checking the capacity of the digestive system and the outdoor sports department but also with regard to establishing unprecedented success in the redistribution of the currency.

A personal note that we are very happy to cover pertains to John Reib of Shaw Industries Inc. John's card now reads Vice President of that Company; also he has removed his moustach. My only conclusion with regard to the latter is that it has served its purpose by way of convincing the Corporation that he is now a man.

I have been wanting to extend a special credit mention to a rather new Erie Company which many of us oldsters in the section hold in very high regard. I refer to Finish Engineering Company, whom we consider as basically producers of painting masks and associated fixtures. It did not take long for the local molders to commence stretching the territory of the company to cover such things as cement application fixtures and side lines of that category, which were successfully handled without hesitation. However, it would appear that one customer recently threw a curve at them by approaching them for salvage fixtures to reclaim a couple of truckloads of rejected assemblies with irregular cemented seal. I understand that Finish Engineering Company took this project in their stride, developing heat-sealing procedure and fixtures in considerably less than one weeks time at a total cost of a few percent of the merchandise value involved.

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THE *Injection* MOLDERSCOPE

By A. R. Morse

President, Injection Molder's Supply Co.

"It is the freedom to disagree, to quarrel with authority, in intellectual matters to think otherwise, that has made this nation what it is today." Dr. James B. Conant

THE CLOUDY CRYSTAL BALL

Fall 1954 sees more used injection machines on the market than at any previous time in our industry's history. Prices of used injection presses have tumbled steadily since last year at this time, and are now a soft 50% below the all time peak of 1950-51. In other words, the bellwether '46 Reed 8 that brought $12,000.00 in 1951 now waits for a buyer at around $6,000.00, and other used presses are priced accordingly.

Two factors contribute to this situation. First, obsolescence—the glut of new presses pouring from the equipment makers' plants. IMCO has greatly expanded its capacity. Fellows is offering an 8 for around $15,000.00. Reed-Prentice has completed much of its redesign and is now in volume production. HPM has modified many specifications to come up with the most competitive line they have ever had. Lester and Watson-Stillman continue to refine and improve their line. It all adds up to plenty of good, fast new presses being readily available, and in many cases terms being offered are just too good for a molder to refuse. At no time in the history of injection molding has competition among equipment makers been so keen —and at no time before has this stiff competition jelled so many improvements in machine design and performance. Features that molders used to beg for are now standard equipment on new machines.

The second factor that contributes to the glut of used injection machines and to the idle presses scattered around the country is more basic, more touchy. Take toys—there has been a widespread reaction against thermoplastics in this field because a few molders cut too many corners, made misapplications, and caused buyers to look askance at all plastics. Take housewares and the cracked dishes we hear about. Take almost any field —refrigeration, novelties, automotive —as competition gets tougher you see less thermoplastics being specified. It's not necessary to document the beefs against misapplied thermoplastics—you get them everywhere, in Fortune magazine, from the SPI, from buyers' handbooks. You add all this up and it spells the fact that we now have plenty of capacity to mold everything the market will absorb.

Another sign is very clear that we have reached a turning point of some kind—and that is the increasing use of Nylon, and the increasing number of molders using it. While this has been a steady upward trend it has now reached what seems to be significant proportions. I interpret it as a crying need for higher melting point thermoplastics. By this I mean a good boilable material like Nylon that will sell at the price of styrene. If and when such a material becomes available, it will assure the basic stability our industry so badly needs, and do much to overcome the widespread feeling that "all" thermoplastics are "no good."

Therefore, with plenty of new machines available, with dozens of used machines on the market, with our customers more or less surfeited with thermoplastics, I predict some casualties in the injection field. The signs are apparent — this plant for sale (name on request), that plant going thru 77B (name on request), another in the hands of receivers (name on request), another being run by a bank in the course of refinancing (name on request). Only emphasis on quality can stem the tide this time.

It seems that there is less concern about the future, more stability, fewer idle presses in those shops which have developed proprietary lines, as opposed to the straight custom molder. This is just an impression one gets from time to time, and it may be due to the boom or bust way custom work has of coming in lumps. In either event, our capacity today certainly exceeds the realistic demand for our products, and I predict the molders who have always put out quality products in the face of cut-throat competition are going to prove the saviours of our business in the long run, concerns like Plas-Tex, Tri-State, Tupper, Kent and the others who have steadfastly refused to compromise on quality or wall section.

HEATERS AGAIN

Evidence continues to accumulate that certain materials should never be molded without an increased maintenance cost for heater repairs being included in the cost of the job. Vinyl butyrate, saran, and teflon as can be made (in simple terms) to break down to produce acids which at elevated temperatures used in molding will dissolve any steel or any chrome. A glance at the atomic table shows this, but many people in our business simply refuse to take such a basic attitude, and persist in maintaining that either molding powder or the heater is defective. Now literally millions of pounds of these materials are molded each year, so such a stand is scarcely tenable. Today 99% of all molding problems with these powders are due first to over-rating heating cylinders; second, to plain careless operation where cylinders are allowed to soak at operating temperature, and third, to accidental situations where excess heat is applied, causing material decomposition. But even in normal operation, these materials have a tendency to shorten heater life, and the cost of these unavoidable expenses should be calculated in advance and figured into the job. Our own experience has shown that if this is done it is far less expensive to simply use a standard cylinder and maintain it by periodic overhauls than to go to special heating cylinders with the hope of avoiding these maintenance costs. We have compiled repair and maintenance figures for our heaters and can now give an estimate of approximate additional costs for extra maintenance which should be used in molding the various specialty powders. Undoubtedly, you could also obtain these costs for original equipment cylinders from the machine maker. You should know them and use them, or you're likely to find it unprofitable to mold these powders because of the net effect of the unavoidable extra maintenance on cylinders which takes the profit out of the job. My observation is further substantiated by the fact that runs with specialty powders are often of comparatively short duration, and only later does it become apparent that the cylinder won't clean up again for use on other plastics. It's just another one of things that have to be learned by costly experience, and that makes injection molding so unpredictable—and interesting.

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SECTION NEWS

Edited by

Stanley Bindmen

Jamison Plastic Corp.
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North Bellmore, L.I., N.Y.

Southern Section Hears Talks on Extrusion Problems and the Science of Advertising

C. Veazey LeCraw

The Southern Section has continued to grow in number and enthusiasm since its beginning in February of this year under the able leadership of President Raymond W. Kruse, Rohm & Haas. Our Membership Chairman, Lee J. Diamond, Koppers Co., has been emphasizing the importance of building up the membership of our chapter in order to increase its influence and effectiveness. Robert Jones, Glidden Co., our Program Chairman, has been arranging very interesting meetings. Harry W. Hagmeier, Owens-Corning, Project Committee Chairman, is in the process of preparing a brochure on the Southern Plastics Industry.

Two members of our own section gave very interesting talks at our May and June meetings. Mr. Jules W. Lindau, III, Southern Plastics Co., who is our Vice President and a national director, talked to us at our May meeting on "Some Extrusion Problems and Their Solutions." Mr. Lindau has a vast amount of personal experience in working out extrusion problems. He told of the four major areas of variables in the extrusion process. These are (1) quality of materials, (2) the hopper, cylinder, and screw, (3) the die, and (4) the methods used for take off and cooling.

Mr. Harald J. Torgesen, our section secretary and vice president in charge of advertising for Gladwin Plastics, gave a most interesting discussion on the latest in the science of advertising at our June Meeting. Mr. Torgesen has had over 20 years experience in this field and knows how to put a product before the eyes of the public, which is a valuable asset in any business.

For our July meeting, the section had a very enjoyable outing at which the members and their ladies enjoyed some delicious barbecue. We are planning to have at least one such occasion every year.

Quality Control Lectures

A repetition of the successful lecture series on Statistical Quality Control has been announced by the Bruce Mann Associates. The series consists of seven lectures at the elementary level. Meetings will be held at The Essex House, Broad St., Newark, N. J., beginning Thursday, October 7, 1954, at 7:30 P.M., and on each successive Thursday thereafter. The fee for the entire series of seven lectures is $35. Further information and registration forms may be obtained by writing to: Bruce Mann Associates, 433 Park St., Upper Montclair, N. J.

Effective Design Talk Interests Washington

Irvin Wolock

At the May 11, 1954 meeting of the Baltimore-Washington Section of The Society of Plastics Engineers, held at the Candlelight Lodge in Baltimore, Mr. Alfred M. Blumfield, head of the Design Section of the Rohm and Haas Company discussed "Effective Design of Molded Acrylic Parts". The design program Mr. Blumfield discussed, was awarded a citation by the Philadelphia Industrial Designers Institute as having done the most to advance the profession of industrial design in the Delaware Valley Area in 1953. The important factors involved in the use of acrylics for molded parts are a knowledge of the physical properties, of optical design, and of the use of decorative techniques and methods of attachment. These factors were discussed in detail.

The programs tentatively scheduled for the first half of the 1954-1955 season are: Oct. 12 — Properties, Processing and Applications of Rigid Polyvinyl Chloride; Nov. 9 — The Effect of Nuclear Radiation on the Properties of Polymers; Dec. 14 — The Fluorocarbon Plastics; Jan. 11 — Effects of Aging on the Properties of Plastics.

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Thermal Degradation of Polymers . . .

(continued from page 32)

impact strength, can as yet be only interpreted in a qualitative and empirical fashion. The essential ultimate property measured in an impact test is the amount of energy necessary to cause failure rather than the maximum stress supported by the sample and as such depends on both the high speed modulus as well as the ultimate stress[3]. The results of the Izod notched impact strength measurements on samples of molded high impact polystyrene, at two different molding temperatures are summarized in Table II:

Table II

Izod notched impact strength of Koppers Modified High Impact Polystyrene as function of the number of molding cycles

No. of cycles	Impact strength (ft.-lbs. / in. of notch) 460°F.	560°F.
0	0.44 ± 0.01	0.35 ± 0.01
1	0.41 ± 0.01	0.31 ± 0.01
2	0.40 ± 0.01	0.30 ± 0.01
3	0.40 ± 0.01	0.36 ± 0.01
4	0.42 ± 0.01	0.35 ± 0.01
5	0.39 ± 0.01	0.37 ± 0.01
6	0.44 ± 0.01	0.35 ± 0.01
7	0.43 ± 0.01	0.35 ± 0.01

At both temperatures the impact strength of the molded polystyrene sample levels off at a value not very different from that of the original material. In view of the probable low extent of degradation (e.g. about 10% for polystyrene) under these molding conditions this behavior is not surprising since ultimate rheological properties of polymers of sufficiently high D.P. are not markedly affected by changes in molecular weight[3]. The existence of a minimum in the impact strength around three molding cycles should be viewed with caution since the impact strength measurements show considerable scatter. The temperature dependence of the polystyrene impact strengths is small; the impact strength decreases with an increase in temperature.

The Izod notched impact strength data of molded samples of cellulose acetate, as a function of the number of molding cycles at a cylinder temperature of 510°F are summarized in Table III:

Table III

Impact Strength (Izod, notched) of Medium Grade cellulose acetate (Hercules) at 510°F.

No. of cycles	Impact Strength (ft.-lbs. / in. of notch)
1	2.70 ± 0.05
2	2.95 ± 0.05
3	2.90 ± 0.05
4	2.75 ± 0.05
5	4.35 ± 0.05
6	4.70 ± 0.05

The increase in the impact strength of cellulose acetate with the number of molding cycles has been repeatedly checked.

In due course, the effect of the number of molding cycles on other physical properties of other commercial polymers will be reported. The authors are indebted to the Chemical Division, Koppers Co. and the Hercules Powder Co., for samples of commercial polymers.

Normal Frequency Distribution . . .

(continued from page 30)

quality characteristic; the number of defects in a complicated molded piece might be another. There is a frequency distribution somewhat similar to the *Binomial* which can be used to describe the type of variation occurring in counted data of this type. This distribution is called the *Poisson distribution*. Mathematical tables showing the percentages to be expected within certain limits are available for the Poisson distribution. Much use has been made, especially in the metal working industries, of the Binomial and Poisson distributions. Many of these uses are applicable to the molding industry and much literature has been written about the techniques which were found to be most useful. We have merely tried to indicate here the existence of these distributions so that the interested reader can pursue this study further.

Many advantages can be gained in considering the variation in a process on the basis of the distribution pattern which is set up. Decisions for quality improvement can be made based on the overall pattern of variation, and the errors inherent in basing decisions on too little data can be avoided. In addition, the causes of irregular variation can often be pinpointed by the type of change that each causes in the distribution pattern.

Much of the growth of mathematical interpretation of quality data (and other operating data) has resulted from the use of the Normal and Binomial distributions for representing the expected variation of a process, and the expected chance error in the testing methods. Tests for showing how confident we may be in making all kinds of management decisions on available data have been developed, and are at the fingertips of Quality Control and management personnel. Further uses of these methods are being developed almost daily, and it is due to the creative imagination of Quality Control and Production people that practical applications are being made. The next article in the series will show how the ideas discussed in this paper may be extended to day to day Quality Control operations.

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2) Statistical Quality Control—E. L. Grant (McGraw-Hill)

3) Introduction to Statistical Analysis—Dixon and Massey (McGraw-Hill)

CLASSIFIED ADS

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Tool Steels For Plastic Molds . . .

(continued from page 27)

comparison with the "optimum" and "overheated" samples gives a logical explanation for this condition.

A further evaluation of polishing and heat treatment, in general, indicates that finish is directly related to hardness. In addition, some strides have been made in the metallurgical laboratory to correlate metallurgical microstructures with the ability to produce polished finishes. Figure 23 will help to illustrate this work. This photograph, showing the composite group of six microstructures, represents two experimental cold hobbing steels. The "A" suffixes indicate one grade and the "B" suffixes the other. The samples marked "1" were given an optimum carburizing heat treatment. The samples marked "2" were given a carburizing heat treatment designed to determine the effect of high carburizing and quenching temperatures and longer carburizing time. The samples marked "3" were given a single treatment sometimes used in commercial practice.

In reviewing the case microstructures, it is obvious from a metallurgical viewpoint that they would be rated in this order:

Best—Sample 1A
Second—Sample 2A
Third—Sample 1B
Fourth—Sample 2B
Fifth—Sample 3B
Last—Sample 3A

It will be noted that Sample 3B shows evidence of retained austenite and that Sample 3A shows large quantities of retained austenite. Duplicate samples of these specimens were sent to two well-known mold building establishments for experimental polishing. Their ratings as to finish and polishability were identical in order with those of the metallurgical laboratory. In addition, some "comet tails" were noted in Sample 3B and an "orange peel" finish was obtained on Sample 3A.

Continuing our discussion of polishing and, in particular, of pitting of the mold surface, let us review some of the causes of pitting. In our experience with pitting, we have noted at least eight distinct causes. First, actual voids or pinholes in the steel itself will show up as pitting. These usually show up in isolated spots or clusters. Pitting can also be caused by the use of wet carburizing compound. Under certain conditions, the moisture and the sulfur present combine to form sulfurous or sulfuric acid and thereby attack the steel. The production of retained austenite usually will produce a uniformly pitted surface. Sometimes conditions are such that the moldmaker removes too much stock after carburizing, which results in the bringing of the secondary case structure to the surface. This structure is usually 4 to 5 points Rockwell C lower in hardness than the prime case structure. A condition such as this invariably causes a difference in the characteristics of the finished product and may cause pitting in polishing or service.

Buffing tends to smear the surface and to drag out minute particles. The use of "loaded" sticks or wheels is very poor practice, but happens more often than you may realize. Dirty shop conditions can cause all sorts of troubles and the pitting of polished surfaces is included. In service, oil from outside the mold cavity may enter the mold by means of movable cores, slides, and ejector pins. Since the vast majority of oils contain sulfur, we again have the problem of possibility of the formation of sulfurous or sulfuric acids and subsequent etching. It can be readily seen from the above, that it takes constant clerical precautions to produce high quality mold surfaces.

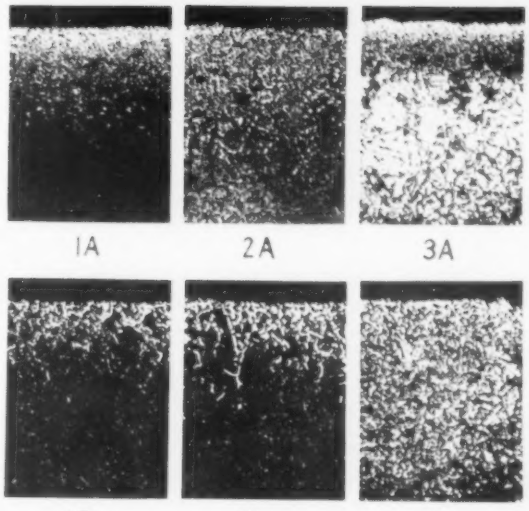

Figure 23: Composite photograph of micro-structure of two experimental hobbing steels showing the effect of three carburizing treatments on the resulting case structure.

These precautions are the responsibilities of all parties concerned.

In conclusion, we hope that we have given you a little better understanding of the tool steel producer's relationship to the plastics molding industry. It is also our thought that by the ultimate in cooperation between the steel producers, heat treaters, moldmakers, mold designers, and molders and the free exchange of concrete ideas, rather than on-the-spot condemnations, the whole future of the plastics molding industry may seem just a little brighter.

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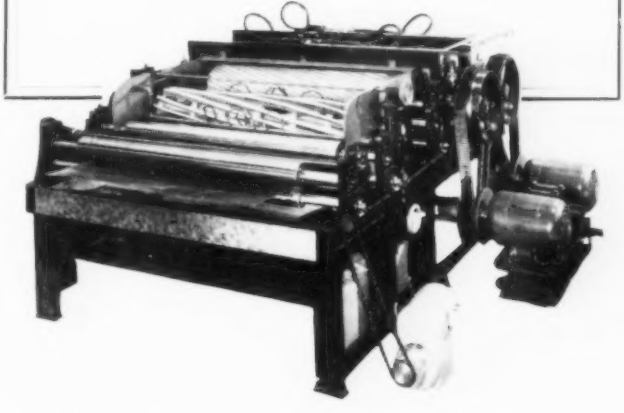

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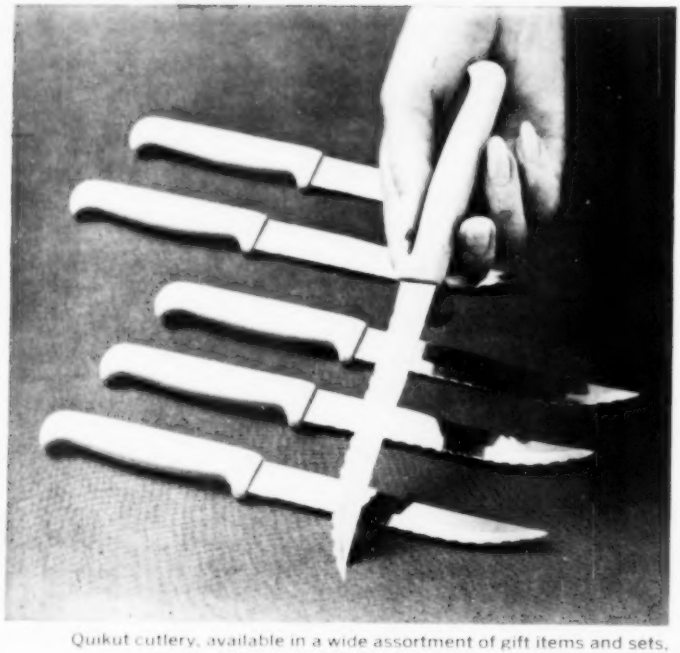

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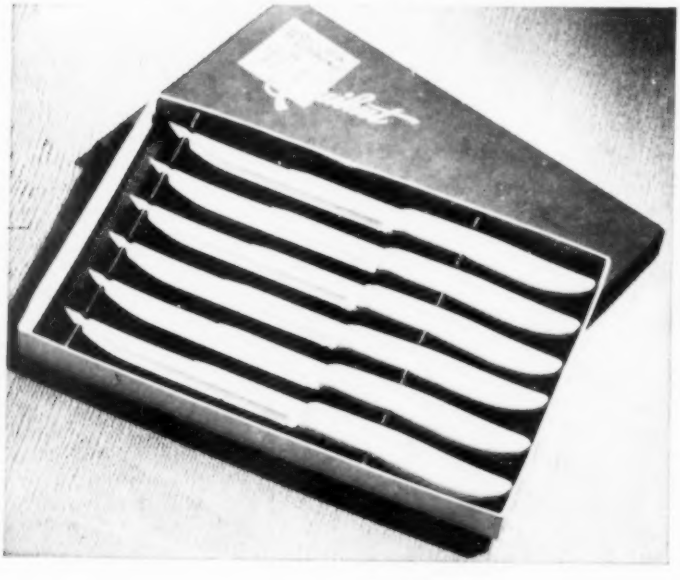

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